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JUST AROUND THE CORNER

By Vernon Mount

With party lines broken down, an odd thing is happening in the USA. Whether it is good or bad, I'll have to leave for history to tell.

A coalition group has dominated Congress for some years. They have saved us from some pretty radical legislation. They cut across party lines, with conservative Republicans and conservative Democrats joining forces in opposition to Administration moves.

Thus the "opposition party" is really no party at all, and the "party in power" is not a party, either, in the usual sense, but an extension of Harry Truman's belief in himself and the friends of the few who still had faith when he stood on the burning deck last election.

Coalition candidates could follow, now that the stage is set. Ike Eisenhower, for instance. Truman has spoken of him as a good Democratic nominee, yet all these years the Republicans have claimed him for their own. He could run on both tickets, and it would be a logical move because he probably could win, as things now stand, on either ticket.

But is that good, or bad from a long-range viewpoint? Do we need two aggressive parties to battle it out? Or will we gravitate to a new set-up whereby the Congress faces the Administration in the opposite corner, with the public holding the gong over both?

Only history can tell, but it is an interesting thing on which to speculate. What do you think? I'd like to know. Write me, won't you?

Yours faithfully,

Vernon Mount

Two completely equipped EXACT WEIGHT Sacking Scales at work in the Jackson Fertilizer plant.

Industry Advisory Committee Holds First Meeting

The U. S. Department of Agriculture's Fertilizer Industry Advisory Committee held its first meeting March 9 in Washington to discuss with Department officials special Government and industry problems arising from the defense mobilization program.

Among subjects discussed at the meeting were reports by industry representatives that boxcar shortages were hampering production and distribution of fertilizer in many parts of the country, and that it was becoming more difficult to obtain adequate supplies of textile and multi-wall paper bags. Committee members also discussed the shortage of sulphur.

L. B. Taylor, director of the Agricultural Conservation Programs Branch and former Director of the Office of Materials and Facilities, Production and Marketing Administration, presided as chairman. L. G. Porter, chief of the fertilizer staff of the Office of Materials and Facilities, is vice-chairman of the committee.

The Fertilizer Industry Advisory Committee includes 28 industry members. Those attending the meeting were:

Richard E. Bennett, Farm Fertilizers, Inc., Omaha, Nebraska, J. F. Doetsch, Chilean Nitrate Sales Corp., New York, N. Y., Ralph B. Douglass, Smith-Douglass Co., Inc., Norfolk, Virginia, A. M. Eno, G. L. F. Soil Building Service, Ithaca, New York, B. V. Fall, The Rogers & Hubbard Co., Portland, Con-

(Continued on page 54)

It Seems to Me

by BRUCE MORAN

American industry abhors a vacuum. An excellent example of the way such matters are promptly tended to is the Sulphur situation. Hardly had it become evident that this vital chemical would be short, when our industry's suppliers rushed to do something about it.

Freeport Sulphur began working a sulphur dome under marsh water, near Houma, barging to Port Arthur . . . Cyanamid came up with a process to work low-grade ore . . . Chemical Construction unveiled a process making available sulphur which cannot be obtained via the Frasch process . . . and so it goes.

It seems to me there is an excellent object lesson. The laws of economics still stand. Give a man or a company a chance to make an honest profit, and you'll find that American enterprise, Free Enterprise, still can come to the rescue.

Government offices, please note!

Trees

" . . . but only God can make a tree" sang Joyce Kilmer in his Classic poem of World War I. But as we hover around the hinges of World War III, with the ever-present danger of depleting our forests, it is well to take a good look at what can be done to help grow trees.

This issue is, therefore, devoted largely to the subject of Tree Fertiiization. We hope it will prove a useful contribution to the nation.

Trees: NORTH CAROLINA INITIATES THOROUGH EFFORT TO APPRAISE TREE FEEDING RESULTS AND METHODS

Scientists, farmers and the general public are increasingly aware of the important role which chemical fertilizer plays in promoting the increasing production of the food, feed and fibre which our country needs. The industry and agricultural scientists have assembled hosts of statistics to prove without a doubt that fertilizer use results in increased yields and increased profits.

However, almost no experiments have been conducted relative to the results of fertilizer use on tree growth. Recognizing this fact, the School of Forestry and the North Carolina Agricultural Experiment Station have initiated plans to attempt to find out just what these results are. In co-operation with The Solvay Process Division of Allied Chemical and Dye Corporation and The North Carolina Forestry Association, the College has begun a study of the effects of the application at various rates of nitrogen, phosphoric acid and potash on the growth of Loblolly pines.

Field work is being done by Dwight H. Brenneman, a graduate student, under the supervision of Dr. R. J. Preston, Dean of the School of Forestry, who heads the project.

The study will be made on plantations of loblolly pine **(Pinus taeda L.)** located on the Hill Forest in Durham County, North Carolina. The entire experiment will cover approximately seven acres. The youngest stand to be treated is six years old, with other stands being nine, 12 and 16 years, respectively. Each age class will cover an area of 1.86 acres and will consist of 26 plots, except the nine year old stand, which covers 1.25 acres and will consist of 22 plots. Each of the 26 plots will consist of a measured plot 12′ x 59′ and will be surrounded by a 12½ foot isolation strip, making the outside dimension of each plot 84′ x 37′ or 1/14 acre. The reason for the odd-size plots is the limited size of the areas and the effort to maintain an average of fifteen trees per harvest plot. Each of the 22 plots in the 9-year-old stand will consist of a measured plot 41′ x 8′ and will be surrounded by a 12½ foot isolation strip, making the outside dimensions of each pot 66′ x 33′ or 1/20 acre. These plots are smaller because of the limited area and the closer spacing of the trees, but the average of fifteen trees per harvest plot will be maintained.

The plots will be permanently located by four-foot treated stakes painted at the tops. Trees within measured plots will be tagged with numbered aluminum tags nailed 4½ feet above the ground, the nail indicating the point of diameter measurement. At the time of plot establishment the following information will be taken:

A. Designation and location
B. Date of establishment
C. Dimensions and area
D. Number of trees
E. Description
 (1) Forest type
 (2) Age of stand. Method of determination
 (3) Site index. Method and basis of determination
 (4) Climatic conditions
 (5) Topographic features
 (6) Soil samples for analysis
 (7) Litter and humus: Kind, depth, condition, etc.
 (8) Underbrush: Species, density, height, etc.
F. History of stand
 (1) Origin and development
 (2) Disturbances caused by game, insects, fungi, wind and ice
G. General summary of silvicultural conditions and growth. As a protection against obliteration of plots, a map of suitable

scale will be made showing the location, number and treatment of each plot. A desirable number of photographs of each plot will be taken throughout the experiment. Each camera point will be permanently marked, and referenced to permanent plot-boundary stations or numbered trees.

Applications of varying quantities of fertilizer will be made to the four age classes according to the outline described below:

Treatment Number	Pounds per acre N	P_2O_5	K_2O
1	0	0	40
2	0	40	40
3	0	80	40
4	80	0	40
5	80	40	40
6	80	80	40
7	160	0	40
8	160	40	40
9	160	80	40
10	160	80	0
11	160	80	80
12	160	80	40 (Broadcast)
13	0	0	0

The fertilizer will be derived from the following sources:

Nitrogen—ammonium nitrate 33% N

Phosphorus—Treble superphosphate 45% P_2O_5

Potassium—Potassium Chloride 62% K_2O

As can be seen from the above outline the treatments will be replicated in each age class which contains 26 plots. In order to replicate treatments in the 9-year-old stand, treatments 11 and 12 will be eliminated. Each fertilizer treatment will be applied annually for three years except treatment 12, which will be applied the first year only. In all treatments except number 12 which will be broadcast, the fertilizer will be dissolved in water and poured into holes made with a mattock. The holes will be three to four inches deep. Because the 6, 12 and 16-year-old trees are spaced approximately 6′ x 6′ the fertilizer holes will also be spaced 6′ x 6′, or one hole for every 36 square feet. In the 9-year-old stand the trees are spaced approximately 5′ x 5′ and the fertilizer holes will also be spaced 5′ x 5′, or one hole for every 25 square feet. The holes will be made midway between the tree rows.

The tree diameters and height measurements will be made during the winter of 1950 and each winter throughout the experiment. The first application of fertilizer was made during March of 1951.

Trees: SUMMARY OF PREVIOUS TREE-FOOD EXPERIMENTS

Addams (1927) conducted nutritional studies on fifty loblolly pine seedlings at Duke University. The seedlings were eight months old and were planted in sand cultures. Various salts and concentrations of salts were used with nitrogen in the form of nitrate or ammonium compounds. At the end of 29 months, it was found that loblolly pine can utilize nitrogen in the form of either nitrates or ammonium compounds. When the acidity was altered over a wide range, it was found that nitrogen in the form of calcium nitrate showed the best development when the solution was decidedly acid (pH 3.8 to 5); when nitrogen was used in the form of ammonium sulphate, the best development was obtained when the solution was more nearly neutral (ph 6). Addams states that it is altogether probable that under field conditions in the piedmont of North Carolina, loblolly pine receives most of its nitrogen in the form of ammonium compounds, for little nitrification occurs.

Wahlenberg (1930) experimented with different mixtures of three types of complete fertilizers on two-year old western yellow pine in the Savenac Nursery in Montana. The best results were obtained in a small group of plots fertilized with fairly large preparations of sodium nitrate mixed with moderate of small quantities of superphosphate or muriate of potash, or both. The fertilizers that brought the greatest results and pounds per acre are as follows:

Nitrogen lbs/acre	Phosphorus lbs/acre	Potassium lbs/acre
320	240	0
480	160	0
480	0	60
320	80	60
320	160	30

Newell, Maury, and Barnette (1930) applied fertilizer to tung-oil trees in an effort to increase the production of tung oil. The experiment was conducted on Experiment Station grounds of the University of Florida. Annual fertilizer applications were started in early March of 1923 and each year until 1928, after which, one-half was applied in March and one-half in June. Cover-crops of crotalaria were grown annually in the test plots. All trees were mulched, once in 1925 with Japanese cane bagasse and once in 1927 with the refuse remaining from Spanish moss after the fiber was removed. The amounts of fertilizer applied and the average tree measurements over a three year period are given in the following table on next page:

Kerbosch and Spruit (1931) applied increasing quantities of ammonium sulphate (N), double superphosphate (P), and potassium sulphate (K) to quinine trees (genus **Cinchona**) in an effort to increase the quinine production. The plantations used for this experiment were

Fertilizer Material	Pounds Fertilizer Applied Per Tree 1927	Pounds Fertilizer Applied Per Tree 1928	Pounds Fertilizer Applied Per Tree 1929	Average tree measurements as of 1929 Height Feet	Spread Feet	Trunk Circ. Inches
			Planted 1922—15 trees to plot			
Nitrate of soda	3/4	1	1	9.4	13.2	15
Steamed bone meal	2	3	3	8.9	13.7	14.4
4-8-4, SA, 2%; DB, 2%; SP: MP.	3	4	4	9.3	13.4	14.7
Superphosphate	1½	2	2	8.2	11.4	12.4
Muriate of Potash	1/4	1/3	1/3	9.4	13.4	14
Superphosphate and	1½	2	2	— —	— —	— —
Muriate of potash	1/4	1/3	1/3	9.8	14.1	14.1
Manure	18	20	20	10.2	14.4	15.8
Check (No fertilizer)	0	0	0	8.3	12.4	14.2
			Planted 1923—12 trees to plot			
Cottonseed meal and	1½	2	2	— —	— —	— —
Steamed bone meal	1½	2	2	10.5	14	15.5
Lime only	3	0	0	9.9	11.9	12.5
5-8-4 NS, 2%; SA, 1%; CSM, 2%; SP; MP; lime	3	4	4	10.7	13.1	15.6
Check (no fertilizer)	0	0	0	8.1	10.8	11.3
5-8-4 as above (no lime)	3	4	4	11.2	15.1	15.9
Manure	20	20	20	9.7	12.5	12.8
5-8-4 CSM, 2%; NS, 3%; SP: MP.	3	4	4	10.9	15.6	15.1
Steamed bone meal	5	5	5	11.1	14.6	14

SA—Sulphate of ammonia; DB—Dried blood;
SP—Superphosphate; MP—muriate of potash;
NS—Nitrate of soda; CSM—Cottonseed meal.

The experiment indicates the lack of nitrogen as being the limiting factor in growth, and that a complete mixture containing ammonia, phosphoric acid, and potash gives the maximum growth.

located in Java, Dutch East Indies. Two experiments were set up, one in the Tirtasari division of the Government Cinchona Estate and one on an estate in the neighborhood of Soekanegara (Tjibeber). Both experiments were conducted for two and one half years.

The experiments consisted of 80 and 81 plots, respectively, each 354.8 square meters. The quantities of fertilizers added to the various plots ranged from 282 to 1,427 kg. of ammonium sulphate, 125 to 1,427 kg. of double superphosphate, and 62 to 713 kg. of potassium sulphate per hectare. The following table lists the quantities of fertilizer applied to the various plots:

The soil in the Tirtasari area consisted of a great deal of sand and little clay, while the Tjibeber area contained little sand, with a comparatively large proportion of clay. The soil on the Tirtasari area is a recent volcanic ash and not highly weathered. The soils on the Tjibeber area are very highly weathered. The nitrogen content of the soil was low at Tirtasari, but high at Tjibeber. Readily assimilable phosphoric acid was high at Tirtasari, but low at Tjibeber. The Tirtasari soils were slightly higher in potash than the Tjibeber soils.

QUANTITIES OF FERTILIZER APPLIED IN KG PER HECTARE

Figures by which the application of fertilizers are indicated	0	1	2	3	4	5	6
Ammonium sulphate		282	423	634	951	1427	
Double superphosphate	125	188	282	423	634	951	1427
Potassium sulphate	62	94	141	211	317	427	713

The table shows that the application in each succeeding column is 1.5 times as large as that in the previous column, and the amounts applied to each plot are always in the proportion of 1:2:3.

The greatest yield of quinine from the Tirtasari area was from plots fertilized with 1,427 kg. of ammonium sulphate, 1,427 kg. of double super phosphate, and 211 kg. of potassium sulphate per hectare. The greatest yield of quinine from the Tjibeber area was from plots fertilized with 1,427 kg. of ammonium sulphate, 951 kg. of double superphosphate, and 476 kg. of potassium sulphate. The experiment showed that ammonium sulphate applied alone in large quantities, or in small quantities over a long period gave poor results. It was shown that increases in quinine yield can be obtained by mixing ammonium sulphate with double superphosphate and potassium sulphate when applied to the two soils in question. The experiment also showed that both the fertility and the fertilizer requirements of the soil can be judged accurately from soil analysis data.

Chapman (1933) experimented with one-year old tulip poplar seedlings to find their reaction to various amounts of nitrogen. The seedlings were placed in one-gallon jars and the experiments conducted in a greenhouse under controlled conditions. Ammonium nitrate was added to each jar ranging in the amounts from 0 to 400 pounds of nitrogen per acre. The greatest increase in height growth was obtained during the second season by seedlings grown in soil media with nitrogen ranging from 40 to 100 pounds per acre per year, the heights decreasing with greater and smaller amounts of nitrogen. The greatest average weight of the seedlings occurred where nitrogen was added in the amount of 100 pounds per acre; the weights decreasing with greater and smaller amounts of nitrogen.

Beilmann (1934) applied fertilizer of different concentrations to shade trees in an effort to increase their growth rate. The experiment was conducted in the Middle West. It was shown that the shortage of any one of the three fertilizer elements may be responsible for the reduced growth rate of shade trees. Nitro-

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gen was found to be the limiting factor in nearly all cases, but an application of nitrogen alone was not as effective as a combination of nitrogen and phosphorus. The 10-8-6 formula proved the most effective. There was evidence found to show that trees are selective in their use of fertilizer, they reject whatever is not needed, making the formula of less importance than the quantity. Small trees were given half their calculated dry weight of 10-8-6 and 15-30-15 fertilizer. This meant using as much as 25 pounds for trees under three inches in diameter. One tree averaged 42 inches terminal twig growth the same summer; another produced shoots eleven feet long and made a total shoot growth of 69 feet in one growing season. The rate of growth of small pin oak trees and the amounts of fertilizer applied was as follows:

Date	Fertilizer Formula	Amount per Tree	Increase in Trunk Diameter/year
		Pounds	Inches
1928	8-4-6	3	.10
1929	4-8-4	4	.10
1930	4-8-4	5	.45
1931	8-8-4	10	1.05
1932	8-8-4	25	1.20
1933	10-8-6	25	1.35

Batjer and Degman (1937) used varying amounts of nitrogen, potassium, and phosphorus to study their effects on the growth of one-year York Imperial apple seedlings. The seedlings were planted in soil cultures and kept under greenhouse conditions. Nitrogen was used in the amounts of 2, 5, 15, 30, 60 and 168 parts per million; potassium in the amounts of 0, 2, 4, 10, 30, 60 and 117 parts per million; phosphorus in the amounts of 0, 2, 4, 10, 20, 40 and 93 parts per million. Seedlings grown with nitrogen added at the rate of 66 parts per million, made somewhat less growth than when added at the rate of 168 parts per million. Reduction below 60 parts per million reduced the amount of growth almost quantitatively. Potassium at the rate of 60 parts per million gave less growth than with 117 parts per million, and less growth with each decreasing concentration. Only when phosphorus was completely lacking did visible deficiency systems occur.

Chandler (1938) used a mixture of equal parts of sodium nitrate and ammonium sulfate to fertilize beech and maple trees in a natural forest stand in an effort to increase seed production. He used square, quarter-acre plots with a 25-foot isolation strip between plots. Each fertilizer plot had a check plot adjacent to it. Fertilizer applications were at the rate of 1,600, 3,200, and 4,800 pounds per acre. He suggests that for conifers, smaller amounts of nitrogen in the form of ammonium sulfate might prove more satisfactory since soils supporting a coniferous forest do not readily nitrify. The result was a very significant increase in the total number of seeds produced by both beech and sugar maple trees.

Cullman, Scott, and Waugh (1938) used varying amounts of nitrogen, potassium, and phosphorus to study their effects on the growth of one-year Elberta peach seedlings. The budded stock was planted in sand of medium fineness in three-gallon earthenware crocks and grown under green house conditions. Nitrogen was used in amounts ranging from 2 to 168 parts per million; phosphorus ranged from 0 to 93 parts per million; potassium ranged from 0 to 117 parts per million. The growth was considerably less when nitrogen was added in small amounts, but increased in growth when nitrogen was added in amounts up to 60 parts per million. Some of the trees receiving 120 to 168 parts per million were larger, but not significantly so. Potassium did not show the marked difference in length of stem and lateral growth as did nitrogen. When phosphorus was added in the amount above, four parts per million, there was no marked difference in the growth. Growth was as good at four parts per million as at 40 parts per million. At two parts per million the growth was reduced significantly.

Scott (1938) used fertilizer in an Elberta peach orchard which was planted on land recently cleared of the native growth of longleaf pine and scrub oak located in the sandhill area of the southeast. Complete fertilizer treatments were begun the spring following planting and continued for a period of nine years. Nitrogen was derived 80% from nitrate of soda and 20% from cottonseed meal, phosphorus from acid phosphate and potassium from muriate of potash. Nitrogen was applied at the rate of .10 pound NH_3 per tree, phosphorus at .05 pound P_2O_5 per tree, and potassium at .05 pound K_2O per tree. After the second year and for each year following, the rates were increased to .8 pound NH_3, .4 pound P_2O_5 and .4 pound K_2O. The five treatments which were used are as follows:

1. No fertilizer
2. Nitrogen only
3. Nitrogen + phosphorus
4. Nitrogen + potassium
5. Nitrogen + phosphorus + potassium

After nine years of the experiment, the trees having no treatment and those receiving nitrogen only, were much smaller in trunk growth. The trees receiving nitrogen plus phosphorus showed greater average diameter growth than the trees receiving the complete fertilizer. The trees receiving nitrogen plus potassium showed less diameter growth than those receiving nitrogen plus phosphorus.

ANNUAL INCREASE IN CROSS-SECTION AREAS (SQ. CM.)

Treatment	1930	1931	1932	1933	1934	1935	1936	1937	1938	Average
No. Fert.	4.94	6.04	14.73	17.54	13.82	8.62	2.94	12.87	11.10	10.29
N	9.05	10.45	17.93	20.80	20.75	3.11	5.35	16.73	9.05	12.59
N P	10.08	11.64	26.67	25.69	19.40	15.51	11.61	30.31	20.22	19.01
N K	6.66	10.00	23.70	19.60	24.46	11.55	5.56	16.40	10.34	14.25
N P K	9.52	12.38	32.44	23.37	21.50	15.23	10.10	26.39	18.20	18.80

Until trees were three years old, all fertilizer applications were made under the spread of the crown, after which the fertilizer was broadcast as an overall application. Plots consisted of single rows eight trees long, separated by buffer rows and arranged in triplicate series with every fifth plot serving as a check plot.

Mitchell and Chandler (1939) used various amounts or nitrogenous fertilizers on certain deciduous trees of the northeastern United States. The nitrogen was applied at the rate of 0 pounds to 900 pounds per acre. The fertilizer used consisted of an equal mixture (by weight) of commercial nitrate of soda and sulphate of ammonia. The diameter growth of the trees increased with the addition of nitrogen at the rate of 300 to 500 pounds per acre. An increase in nitrogen above the above amounts resulted in smaller increases in radial increment.

Chadwick (1941) applied a complete fertilizer of various concentrations to ornamental shrubs and evergreens. For narrowleaf evergreens a 10-6-4, 8-5-3, or 4-12-4 fertilizer is recommended. The fertilizer should be applied at the rate of two to four pounds per 100 square feet of bed area each spring. Chadwick suggests that the fertilizer be hoed or watered in.

Cummings (1941) applied a complete fertilizer to shortleaf pine, white ash, and yellow poplar seedlings at the time of planting. The fertilizer was used in an effort to reforest abandoned farm lands and spoil banks in the Central States. Three experimental blocks were located on different adverse planting sites. Two blocks were located in old fields and the other block on steep spoil banks. The fertilizer was mixed on the basis of weight of N, P_2O_5, and K_2O. The carriers used were ammonium sulfate with N at 20.6 percent, superphosphate with P_2O_5 at 20.0 percent, and potassium sulfate with K_2O at 51.9 percent. Twenty-seven mixes were made up representing all possible combinations of three levels of nitrogen, phosphorus, and potassium. The fertilizer was applied at the rate of 100 pounds per acre to the planting holes at the time of planting, and the three levels of nitrogen, phosphorus, and potassium were represented by 0.26, 0.52, and 0.78 grams per tree, respectively. From the statistical analysis the main effect of nitrogen on shortleaf pine growth was not significant, although it appeared beneficial on two of the three blocks.

Hunter and Lewis (1942) used a complete fertilizer in an effort to increase the growth of pecan trees. The experiment was conducted on soils of the Southeast. At the beginning of the experiment a complete fertilizer 6-8-4 was applied at the rate of 60 pounds per tree, or 1,200 pounds per acre. Three years later the fertilizer used on the same areas was 4-8-4 at the rate of 50 pounds per tree, or 1,000 pounds per acre. A winter green manure crop was grown each year and worked into the soil in the spring. All the fertilized trees made larger increases in cross-sectional area than the trees without fertilizer.

Wilde, Trenk, and Albert (1942) applied mineral fertilizer, peat and compost to young red pine plantations at the time of planting. The planting stock was 2-2 transplants. Fertilizer was applied broadcast, or in planting holes. The fertilizer consisted of 150 pounds of 20% ammonium sulfate, 300 pounds of 20% superphosphate, and 200 pounds of 50% muriate of potash per acre. The results showed that the average height growth was increased 30% on the fertilized areas as compared to the unfertilized areas. Alkaline peat and horse manure depressed the growth. The authors point out that the most successful treatments hardly justify the cost of the fertilizer and labor. The authors also give a warning against the fertilizing of plantations growing on soils in which a radical nutrient deficiency has not been clearly established.

Bensend (1943) studied the effect of nitrogen on growth of jack pine seedlings. The experiment was set up to determine the optimum concentration of nitrogen, and the effect of variation from that concentration on the growth of jack pine seedlings for the first growing season. The seedlings were planted in a sand culture under greenhouse conditions.

The levels of nitrogen in p.p.m. were 0, 25, 50, 75, 125, 150, 200, 300, 400, and 500. These levels were built up gradually over a period of time by adding a stock solution of NH_4-NO_3 to increase the concentration by 25 p.p.m. It was found that the height and weight of the seedling stems increased with increase in the supply of nitrogen up to 200 to 250 p.p.m. Beyond this there was a decrease in both weight and height. The weight of the roots increased up to 100 p.p.m. and further increase in nitrogen supply resulted in little change. The root shoot ratio decreased until a supply of 100 p.p.m. was reached; beyond this level there was little change.

Wilde (1946) referred to nitrogen as "the balance wheel of plant nutrition." He indicates that ammonium sulfate may be applied at the rate as high as 300 pounds per acre (60 pounds of N) for nursery soils. Wilde also states that 20 percent superphosphate in rates from 100 to 500 pounds per acre (20-100 pounds P_2O_5) will cause better utilization of nitrogen. He also states that potassium is important in the formation and utilization of sugar and starch, synthesis of proteins and cell division. Applications of potassium may be made at the rate of 100 to 300 pounds per acre (50 to 150 pounds of K_2O).

Lutz and Chandler (1947) state that few forest soils are so fertile that a response is not obtained from the addition of some fertilizer constitutent or soil amendment, however, they question whether fertilization in forestry can be justified, because of the greater unit increases in farm crops when fertilizer is applied. The authors point out that fertilization of forests is still in the experimental stage in Europe, although the cost of fertilizer is relative.

Lyon and Buckman (1948) state that the application of a commercial

(Continued on page 58)

Trees: SPRAY-FERTILIZATION OF TREES TESTED BY CALIFORNIA A. E. S.

By Carl Kahan

The Citrus Experiment Station at Riverside, California, spurred on by the success of Eastern apple growers in obtaining better fruit color by spraying their trees with nitrogen carrying fertilizers, has begun similar experiments on orange trees.

Since nitrate of soda and sulphate of ammonia had caused some damage to apple foliage, even at low concentrations, a new urea compound was tried. Experiments were begun in the spring of 1947.

First Trial

Washington navel orange trees, in four groups were used as the subjects.

To the foliage of one group, a spray of five pounds of urea to 100 gallons of water was applied. The second group was treated with a solution containing 7½ pounds of urea; the third was sprayed with a 10 pound per 100 gallon solution, and the last with 15 pound to 100 gallons of water.

These applications were made in February, April and May.

When the leaves were analyzed, however, they showed little or no absorption of nitrogen. The reason for this was that although these trees were non-vigorous, the nitrogen content of the leaves was not the limiting factor. It had, at the beginning of the test been relatively high.

Second Trial

In November of 1947, in Azusa, California, the second experiment was begun. This time the trees were vigorous in appearance but showed the effect of a limited supply of nitrogen. A straight 10 pounds of urea to 100 gallons of water spray was used on all the trees, and it was applied four times: November of 1947, April 1948, August 1948, and November 1948, and showed the following:

The control trees unsprayed, contained 2.39% of Nitrogen.

The sprayed trees contained 2.69% of Nitrogen.

The level of nitrogen nutrifore, was shown to be higher.

As was true for the first trial, no injury was caused to the foliage of the Washington navels and no noticeable response of the trees as a whole was seen.

Third Trial

This time the trees chosen were in the unfertilized block of the long term fertilizer tests at Riverside, California, and were therefore nitrogen-starved.

These navels were given two applications of spray per tree. One was of a 15 pound per 100 gallons of water concentration and was sprayed on in February tion in the sprayed trees thereof 1948. Three months later, in May, the second spray of 10 pounds of urea product to 100 gallons was given.

Ten days after the second application, the leaf analysis was undertaken and the trees, untreated, showed that their leaves contained 2.24% of nitrogen. The sprayed trees, however, had 2.52%.

As a part of this same experiment, a second check of the nitrogen content of the leaves was made the following January, with no additional spray having been given in the mean-time. The unsprayed trees showed 1.99% of nitrogen in the leaves, and the originally sprayed ones had 2.18%.

In this trial, the sprayed trees as a whole, showed a marked increase in green color, a slight increase in growth, and an increase in fruit production. The unsprayed trees had produced very little fruit.

Fourth Trial

Two new factors were the targets for the fourth test.

How would the spray work on Valencia orange trees, and how would it compare in effect with an application of fertilizer to trees in the usual manner?

A group of trees at Mentone, California, were selected which showed the leaf nitrogen to be relatively low. The pale color of these leaves as well as the light crop which had been produced indicated a moderate degree of nitrogen deficiency.

On the first of April these

trees were sprayed with a 15 pounds per 100 gallon solution.

A soil application of an equal amount of nitrogen was made at the same time to the other trees.

The analysis of the leaves made 15 days later, showed the following:

Leaves from unsprayed trees: 2.19% nitrogen.

Leaves from soil fertilized trees: 2.21% nitrogen.

Leaves from sprayed trees: 2.58% nitrogen.

Almost two months later, on May 25th, the soil application was repeated on the same trees. In addition part of the trees first sprayed were now resprayed.

When the analysis of the leaves was made ten days later, this was found:

Leaves from unsprayed check trees: 2.17% nitrogen.

Leaves from soil fertilized trees: 2.17% nitrogen.

Leaves from once-sprayed trees: 2.19% nitrogen.

Leaves from twice-sprayed trees: 2.43% nitrogen.

Again the greater absorption of nitrogen by the leaves was demonstrated.

The next point to be decided is whether the amount of nitrogen that can be absorbed by the leaves will suffice for all the nitrogen needs of the tree. More research will be carried on until the full value of this means of fertilization will be realized.

Trees: LEAF-FEEDING TESTS IN NEW YORK A. E. S.

By MAX E. PATTERSON, Geneva AES

The idea of feeding plants through the leaves is not new. Sprays applied to the foliage have been tried on citrus and tung trees for a number of years. Usually the sprays are used when a deficiency of a nutritional element becomes the limiting factor in the growth of the plant. Under such conditions the deficient element might be applied to the tree as a soil amendment, a spray, a dust, an injection, or as bits of metal driven directly into the plant.

Fig. 1.—Effect of different levels of nitrogen on growth of tomatoes. A, grown on very low nitrogen content solution; B, grown on low nitrogen content solution; C, grown on medium nitrogen content solution; D, grown on very high nitrogen content solution.

Results from such tests showed that sprays applied to the foliage were often the most effective.

More recently, Nugreen (urea) applied as a foliage spray to deciduous fruit trees has been given much publicity. The restoration of a healthy dark green color to poorly colored apple leaves by spraying them with this compound has stimulated wide general interest in nutritional sprays.

In some instances nutritional sprays are the most feasible

Fig. 2.—Comparison of growth of tomatoes occasioned by nitrogen increases through the foliage and through the roots. A, grown on very low nitrogen content solution; G, grown on very low nitrogen content solution plus bi-weekly urea sprays beginning the sixth week after transplanting; H, grown on very low nitrogen content solution until the sixth week when the nitrogen in the solution supplying the roots was raised to the medium level.

method of alleviating deficiency symptoms. Less material is required when an element is sprayed on as compared to putting it in the soil. The response to sprays is also more rapid. Where sprays are required for insect or disease control, nutritional sprays may be included in the regular schedule.

Some symptoms, however, cannot be totally corrected by the use of nutritional sprays. Sometimes subsequent new growth will continue to be chlorotic even though the spray had apparently effected recovery in the older leaves. Not all plants respond to nutritional sprays in the same manner. A spray that is effective in supplying nitrogen for apples may have no effect on tomatoes. Also, the compound that works the best for a given nutritional spray may not be easily obtained or comparable in price to other compounds that are effective as soil amendments.

Elements Responding As Leaf Sprays

There are indications that most of the elements essential for plant growth will give a response when applied in the right compound as a foliage spray. Urea as a spray has supplied nitrogen to growing apple trees the most successfully of a number of nitrogen compounds tested.

Phosphorus compounds that have proved effective as nutrient sprays are rare and expensive. Ammonium metaphosphate may be successful in supplying phosphorus.

Potassium chloride has been used in some areas in the regular spray schedule on celery.

The primary use of minor elements in sprays has been in correcting deficiency symptoms. Iron sulfate has proved practicable for correcting chlorosis due to iron deficiency. Magnesium sulfate, high magnesium spray lime, and epsom salts have shown equally good results in increasing the magnesium content of leaves. Manganese sulfate, zinc sulfate, and copper sulfate are generally used for correction of manganese, zinc, and copper deficiencies, respectively. A single application of borax as a spray or dust is recommended in areas where soil applications of borax fail to supply the necessary boron.

Tests at Geneva

Investigations have been undertaken at the Experiment Station at Geneva to determine how well foliage sprays containing essential elements will supply the needed element to vegetable canning crops. During the past winter Red Jacket tomatoes and Detroit Dark Red beets were grown in sand cultures in the greenhouse at different nitrogen levels—very low, low, medium, and very high (milli-equivalents of N per liter 0.18, 1.8, 18, and 36, respectively). The plants received the same amount of the necessary elements except nitrogen by flooding the sand three times daily at the start and four times daily later.

A series on the lowest level of nitrogen received urea sprays twice a week, beginning at 4, 6, 8, and 10 weeks after transplanting. A comparable series was established in which the nitrogen in the solution was raised from the low to the medium level, starting at the 4-, 6-, 8-, and 10-week periods.

Preliminary results indicate that although the tomatoes could stand a slightly higher nitrogen content in the solution that the beets, the beets could tolerate a more concentrated nitrogen spray. The plants showed a moderately better growth as a result of the nitrogen sprays. However, all the plants getting the additional nitrogen through the roots were far superior in size, color, and set of fruit to any receiving it through the leaves, regardless of when the supplementary nitrogen was added.

Indications at present are that applying fertilizers to the soil still remains the best method for feeding vegetable canning crops. Nutritional sprays are best used as emergency treatments for overcoming acute deficiency symptoms.

The Frank G. Hough Co., Libertyville, Illinois, played host to more than 200 Distributors from the United States and Canada, at a "New Plant—New Products" Show.

Trees: RESPONSE OF LEMON TREES TESTED BY CALIFORNIA GROWERS

By DR. DANIEL G. ALDRICH

(The paper, presented at the 27th Annual Convention of the California Fertilizer Association, represents the joint research by Dr. Aldrich and Mr. J. J. Coony, Farm Advisor in San Diego County.)

Leaf symptoms described as indicative of a low potassium content in lemon leaves in the field are also indicative of a low phosphorus content. Injections of a solution containing phosphorus and potassium into the trunk of affected lemon trees adequately supplied with nitrogen producted marked vegetative growth responses. From preliminary experiments it appeared that the injection of a solution containing both phosphorus and potassium was slightly more effective than where a solution containing ony phosphorus was injected. Stimulation of vegetative growth by the injection of a solution containing only potassium was questionable.

Exploratory fertilizer trials to determine the effect of soil applications of phosphorus and potassium fertilizers on lemon trees showing leaf symptoms associated with a low content of phosphorus and potassium were established in four locations. The first trial was established in the spring of 1949 by the Growers Associated Laboratory of Santa Paula, California, in the lemon grove located near Fillmore, California, where the original injection experiments were located. The remaining three trials were established in San Diego County in November, 1949, by Mr. Joe Coony, Farm Advisor in that county and co-author of this report. The trials in San Diego County are located in groves near Escondido, Rancho Santa Fe, and Vista, California.

The grove near Fillmore is located on a Yolo gravelly, fine sandy loam, the one near Escondido on a Fallbrook sandy loam, the one near Rancho Santa Fe on Olivehain loamy fine sand, and the one near Vista on Las Flores loamy fine sand. The soils of all the test plots are moderately acid in reaction to a depth of two feet.

The trees in the grove near Fillmore are Eureka lemon on Rough rootstock, those near Escondido are Eureka on Sweet orange rootstock, those at Rancho Santa Fe are Lisbon on grapefruit rootstock, and the trees in the grove at Vista are Eureka on grapefruit rootstock.

Four fertilizer treatments involving five single tree replications were applied broadcast in one application at each location. The treatments were as follows: Treatment 1. **Nitrogen** at the rate of seven pounds of ammonium nitrate per tree (2.3 pounds of N per tree). Treatment 2, **Nitrogen plus Phosphorus** at the rate of 20 pounds of 11-48 per tree (2.2 pounds of N and 9.6 pounds of P_2O_5 per tree). Treatment 3, **Nitrogen plus Potassium** at the rate of seven pounds of ammonium nitrate per tree and 20 pounds of potassium sulphate per tree (2.3 pounds of N plus 10 pounds of K_2O per tree). Treatment 4, **Nitrogen plus Potassium** at the rate of 20 pounds of 11-48 per tree plus 20 pounds of potassium sulphate per tree (2.3 pounds of N plus 9.6 pounds of P_2O_5 plus 10 pounds of K_2O per tree).

Results

Within four months after the fertilizer treatments were applied at the various test locations (regardless of time of application, in the spring or fall), marked improvement could be seen in the vegetative characteristics of lemon trees receiving phosphate fertilizer. Little, if any, improvement could be found in the trees fertilized with nitrogen or nitrogen plus potassium. A possible explanation of this relationship of vegetative response to fertilization may be found in the leaf analysis data presented in Table 1. All leaf analysis data reported in Table 1 were obtained on leaves which were collected during May from the most recently matured cycle

of growth found on the variously fertilized trees.

This age of leaf seldom, if ever, shows the leaf spotting associated with a low phosphorus and potassium content. Phosphate fertilization has, with the exception of the grove at Escondido, consistently increased the phosphate content of the lemon leaves from a deficient level (less than .08 per cent P) to a sufficient level (greater than .10 per cent P). The potassium content of the leaves collected from the various groves appears on the other hand to be adequate without potassium fertilization (above .35 per cent K). The grove at Escondido is again an exception to this relationship. However, analyses of leaf samples collected from the grove at Escondido at bimonthly intervals since May show that phosphate fertilization has raised the phosphorus level of the leaves above 0.1 per cent and that the potassium content of the leaves, regardless of fertilizer treatment, is above 0.4 per cent. The adequacy of potassium in recently matured leaves and the inadequacy of potassium in leaves showing leaf spots taken from the same trees can in all probability be attributed to the age difference that exists between the two series of leaves. Leaf spots are always found on the **oldest** leaves on the tree. In view of the fact that the potassium and phosphorus content of leaves decline with age it is not surprising that lemon leaves showing spots are consistently low in phosphorus and potassium. Since lemon trees showing leaf spots respond to phosphate fertilization and not to potassium fertilization, it appears that the composition of recently matured lemon leaves is a better indication of the nutrient status of the lemon tree than is the composition of the older leaves which show spots. The symptoms found on the older leaves, however, provide a field method for recognizing a nutrient deficiency in lemons which after careful consideration of the existing experimental evidence appears primarily to be associated with phosphorus.

TABLE 1

Chemical Composition of Lemon Leaves Collected from the Nitrogen, Phosphorus, and Potassium Fertilizer Plots (per cent dry matter)

Grove	Treatment	Ca	Mg	K	Na	P	S	Cl
Fillmore	N	3.87	.23	.60	.07	.08	.28	.06
	NK	3.61	.19	.89	.07	.08	.30	.06
	NP	4.81	.25	.47	.07	.11	.29	.09
	NPK	4.18	.19	.76	.07	.10	.28	.05
Rancho Santa Fe	N	4.14	.30	.78	.08	.06	.40	.11
	NK	4.86	.35	.50	.06	.06	.36	.11
	NP	4.02	.27	.59	.07	.10	.37	.09
	NPK	4.14	.41	.61	.07	.09	.38	.09
Vista	N	3.74	.29	.57	.07	.06	.33	.14
	NK	4.69	.48	.31	.09	.07	.60	.17
	NP	4.42	.41	.54	.08	.16	.38	.14
	NPK	3.73	.27	.57	.08	.11	.33	.11
Escondido	N	4.74	.34	.20	.07	.06	.30	.12
	NK	4.84	.44	.23	.09	.06	.36	.17
	NP	5.18	.39	.24	.09	.09	.34	.11
	NPK	5.64	.39	.25	.07	.08	.34	.11

Inasmuch as these findings constitute the first report, as far as the authors are aware, of a well-defined response of lemon trees to phosphate fertilization, a detailed description of the leaf symptoms associated with the deficiency will be presented. While these symptoms have been described elsewhere, this is the first time that they have been associated with phosphate deficiency in lemons. Lemon leaves showing typical leaf spot symptoms are shown in figure 1. The spots, which are brown to black in color depending upon how recently the surface burned, are generally circular in shape but occasionally coalesce to form an elongated ovalar spot. The spots occur on the upper side of the leaf usually between the main lateral veins. They are distributed somewhat along and inside the leaf margin and produce a slight depression in the leaf surface. The depression may be surround or partially infiltrated with a resinouselike material. Where the burn is severe on the oldest leaves the center may drop out but generally the burn is confined to the upper surface of the leaf. A view of the lower side of the leaf shows a discoloration of the leaf surface directly below the depressed area of the spot. In the initial stages of the burn the leaf area immediately surrounding the burn is chlorotic and forms a halo. As

the leaf ages the chlorotic area surrounding the burn expands between the main lateral veins so that the oldest leaves appear also to have the chlorotic symptoms associated with iron and manganese deficiency. Since the burn occurs on older leaves it is most prominent in affected lemon trees in the fall of the year becoming most pronounced in October and November. By spring most of the burned leaves have fallen, new growth has started, and deficiency symptoms are scarce. More than normal defoliation during the winter is characteristic of phosphate deficient lemons. The defoliation may start in early fall and accounts for the broom-like habit of growth seen in many lemon groves now known to be deficient in phosphate. Only the most recent growth flush of leaves remains on the branches. Leaves which show no spots are usually lusterless, and gray-green to bronze in color.

The phosphate deficiency symptoms described herein for lemons have never been found on orange trees, this, despite the fact that orange groves are planted on some of the same properties where lemons show phosphate deficiency symptoms and are under the same management program. Phosphate fertilizer trials on valencia oranges were established simultaneously with lemon trials in one grove in San Diego County in spite of the lack of deficiency symptoms on the oranges. Field observations and leaf analysis data on this orange plot reveal that phosphate fertilization has had no apparent effect on growth or on leaf composition. The lemon trials, however, on the same property have responded. The results (lack of response) which the authors have obtained to date on phosphate fertilization of oranges are similar to those obtained by other investigators who have studied orange fertilization in California during the past 30 years.

In the preliminary report on the response of lemon trees to phosphate and potassium, mention was made of a rootstock effect. Eureka lemon budded to Rough lemon rootstock in the grove at Fillmore show far less symptoms of phosphate deficiency than do Eureka lemons on the same property that are budded on sweet orange rootstock. A similar comparison of the effect of rootstock on the incidence of phosphate deficiency symptoms in lemons in San Diego County is not possible at this time for only one rootstock is involved at each fertilizer test location. Experiments are now being planned to determine the effect of rootstocks on the incidence of phosphate deficiency symptoms in lemons grown on soils of varying phosphate availability. A study of the availability of phosphate in the various test plots, as measured by various methods of chemical extraction, is now being conducted and will be the subject of another report. It suffices to say that the data now available indicate that the groves where phosphate deficiency symptoms are most prevalent and are improved by phosphate fertilization are the lowest in amount of extractable phosphate regardless of the reagent used for extraction.

While the growth response of lemon trees showing phosphate deficiency symptoms to phosphate applications has been outstanding, the effectiveness of fertilizer treatments are finally evaluated in terms of yield. Last February arrangements were made with the owner of the lemon grove located near Fillmore, California, to maintain picking records on all of the trees involved in the fertilizer test plots. On several occasions this has required monthly picking records from this grove. A summary of the lemon yield data obtained from the trees in these plots is shown in Table 2.

TABLE 2

Preliminary Lemon Yield Data from Fertilizer Plots Located near Fillmore and Rancho Sante Fe, Calif. (Yield in Field Boxes)*

Grove		N	NP	NK	NPK
Fillmore†	Mulched plots	14.5	21.6	10.8	22.3
	nonmulched plots	15.0	24.4	12.3	21.8
Rancho S. Fe§		2.1	3.3	1.2	4.1
Escondido§		5.8	8.3	6.6	8.8

* Each yield figure represents the total number of field boxes picked to date from the 5 trees in each treatment.

† The yield data for the plots at Fillmore represent the total number of boxes picked from the 5 trees in each treatment during period February to September, 1950.

§ The yield data from the plots at Rancho Santa Fe represent the boxes of fruit picked from the 5 trees in each treatment at the time of the first pick made September, 1950.

Phosphate fertilization has consistently and substantially increased the yield of lemons in this grove. The data reveal on the other hand that potassium fertilization is reducing the yield of lemons when compared with the yield of trees receiving only nitrogen. It is the authors' opinion that an explanation of this reduction in yield by potassium fertilization can be found in the leaf analysis data presented in Table 1. Potassium additions to the grove near Fillmore have reduced the magnesium content of the trees to a level that is suggestive of magnesium deficiency. Further the addition of potassium with phosphorus appears to have reduced the phosphate level of the nitrogen, phosphorus, and potassium treatment when compared to the nitrogen-phosphorous treatment. The effect of potassium on the magnesium and phosphorus content of leaves has been noted elsewhere. Its effect on the yield of phosphate-deficient lemons is noted for the first time and undue emphasis of this relationship should not be made until more yield information is obtained. Through the cooperation of packing house managers in San Diego County it will be possible for the authors to obtain yield data on the lemon fertilizer test plots established more recently in that area. The first picking records from one of those plots was recently obtained and are included in Table 2. While the yield data from this grove are far from conclusive, the relationship of treatment to yield is similar to that obtained from the orchard near Fillmore. Yield estimates made on groves for which actual yield data are not now available suggest the beneficial effect of phosphate fertilization.

It should be recognized that the four phosphate fertilizer trials described in this report were established specifically to determine if soil applications of phosphate and/or potash would stimulate the vegetative growth of lemons showing leaf symptoms heretofore reported to be associated with a low content of phosphorus and potassium. When it became apparent that soil applications of phosphate were producing pronounced vegetative stimulation then it became obvious that yield data should be obtained from these plots where possible. Recently several new and greatly enlarged phosphate trials have been established in San Diego County on phosphate-deficient lemon groves for the express purpose of determining over a long period of time the influence of phosphate fertilization on lemon yields in these groves. Fruit quality studies also have been started.

Discussion

In the foregoing sections of this report it has been shown that lemon trees which have certain leaf symptoms will respond to soil applications of phosphate fertilizer. Such applications have produced an increase in the quantity and quality of vegetative growth and a substantial increase in the yield of lemons. All of the experimental groves cited in this report were selected on the basis of a general occurrence throughout the grove of the deficiency symptoms described herein. Pathologically induced diseases often found in lemon trees were absent. Chemical analyses of leaves collected from these groves have indicated consistently a direct relationship between the described leaf symptoms and a deficiency level of phosphorus. Leaf analysis has also indicated a direct relationship between vegetative stimulation and increased fruit production and a substantial increase in the phosphorus content of these lemon trees as a result of phosphate fertilization.

The authors would like to point out, however, possible exceptions to the relationship that lemon trees showing leaf symptoms described in this article will respond to phosphate fertilization. These exceptions involve lemon trees that function abnormally due to the presence of diseases like shell bark, gummosis, and phloem collapse. When anyone of these diseases makes sufficient headway in the lemon tree, root decay occurs and nutrient absorption is impaired. Deficiency symptoms may then be produced which cannot be corrected by fertilizer applications. The inability of the diseased lemon trees to absorb nutrients can be confirmed by leaf analysis.

When phosphate deficiency symptoms occur in lemon trees as a result of a soil deficiency, symptoms occur generally throughout the grove. Deficiency symptoms which are a secondary effect induced by disease occur sporadically in a grove inasmuch as they are associated with diseased trees. Such trees are not likely to respond to fertilization. An ex-

ception to this case, of course, would be the diseased tree located on a phosphate-deficient soil. Here correction of the primary deficiency might be possible if the inroads of the disease were not severe and some improvement in vigor of the tree would result. However, the effects of the disease itself would still have to be considered.

Phosphate fertilizer trials have been established in Santa Barbara County on lemon trees inflicted with phloem collapse and which show scattered phosphate deficiency symptoms. These trials have been established for approximately five months, a period sufficient to produce stimulation where a soil deficiency of phosphorus is involved. Yet no evidence of vegetative stimulation or phosphorus uptake by the tree has been detected up to this time. These experiments will be continued to determine if nutrition plays a part in the lemon collapse problem.

Surveys of the incidence of phosphate deficiency in lemons due to soil deficiency are being completed in lemon-producing areas. A resume of these findings will be included in a future report on this subject.

Agnew Merged With Aries

R. S. Aries & Associates, New York, consulting chemical engineers, have acquired the business of William Y. Agnew, consulting chemical engineer also of New York City. This acquisition will further expand the scope of activities of the Aries organization. Mr. Agnew whose work has been in pigments, fertilizers and engineering design, was formerly employed by several companies including National Lead, Dorr and Imperial Chemical Industries.

Link-Belt Distributing New Catalog

Some measure of relief from engineering manpower shortages came in sight as Link-Belt Company started distribution of its new 1,296-page catalog. It contains 1,673 tables and charts of basic data that greatly simplify the problems of designing all kinds of conveyor systems, mechanical power transmission and many different types of processing machinery.

Copies of the eight-pound book, which has been three years in preparation, are being distributed as rapidly as possible to industrial and engineering firms, engineering schools, and libraries. All available copies are being used to cover engineers, estimators and purchasing executives, in whose hands this information will contribute to the rapid solution of immediate problems.

A primary function of the book, which is identified as Link-Belt General Catalog 900, is service as a reference tool. It presents basic engineering data facilitating the selection of chains and wheels, drives, power transmission elements, conveyors and process machines in the combinations which will best satisfy a wide range of functional requirements and operating conditions.

In the Field of
ALLIED FARM CHEMICALS

MILITARY NEEDS ABSORB INSECTICIDES HEAVILY

The farmer is going to have to make his insecticides go further this year, and perhaps for some years to come unless production can be considerably increased. As an example of what is going on, an indication of the heavy demands by the military: In one day, recently the Navy spent nearly 2½ million dollars for insecticides—2 million gallons of bulk, 4 million cans of another type, and half a million pounds of powder.

Increasing markets for forest products, especially the possibility of growing pulpwood on short rotations, brings fertilization of fully stocked young stands within the possibility of economic justification. Approximately 200,000,000 pine seedlings will be planted in the Southern States this year, a large percentage of these on sterile abandoned farm land. If inexpensive fertilizer treatments could measurably increase growth and thus either shorten the rotation or increase the volume of harvest, the increase in income might make this a second procedure. With 59 percent of the area of North Carolina in forest, any activity that would increase the productivity of the forest area could have an important effect on the economy of the state.

WEYL NEW NAC EDITOR

Val E. Weyl, formerly of the USDA Bureau of Entomology and Plant Quarantine's Division of Grasshopper Control has been appointed director of information of the National Agricultural Chemicals Association, Washington, according to Lea S. Hitchner, executive secretary, of the Association. He fills the position vacated by Don Lerch who has established a Washington public relations firm specializing in agricultural services.

Mr. Weyl has had extensive experience in entomology and related work with both government and industry. He has conducted numerous surveys for the Bureau of Entomology and Plant Quarantine in Colorado, Montana and Texas.

As an industry entomologist, Mr. Weyl established and maintained a technical reference library, composed labels for pesticides, edited and prepared articles for company publications used by dealers and customers. In this capacity he also acted as a consultant to the advertising, merchandising and sales departments. Mr. Weyl is a native of South Dakota, was graduated with a B.S. degree cum laude from South Dakota State College where he also took graduate studies.

In addition Mr. Weyl has completed a year of graduate research in fields of entomology and genetics at the University of Wisconsin.

As director of information for NAC, he will edit the NAC News and handle various other information projects.

Pennsalt Develops New Process For Blending DDT-BHC Insecticides

A new process for the uniform impregnation of DDT-benzene hexachloride dusts has been developed by the Pennsylvania Salt Manufacturing Company, it was announced.

The new process is now in use at Pennsalt's new insecticide formulating plant which recently went into operation at Montgomery, Ala., and in the plants of several customer formulators who use Pennsalt's technical DDT and 36 percent gamma isomer BHC.

The process is based on the fact that when technical DDT and Pennsalt's 36 percent gamma isomer BHC are blended in a certain proportion, the resulting combination has a lower melting or setting point than either of the two melted separately. The resulting liquid can be blended with the diluent so that virtually every particle carries some of the active ingredient, in contrast with mechanical mixtures wherein particles of the diluent remain inactive.

Fortunately, the relative proportions or BHC and DDT producing the desired low melting point are quite near the proportions required for commonly used insecticide dusts such as 3-5-0 (3 percent gamma isomer BHC, 5 percent DDT and the balance diluent) and 3-5-40 (same as 3-5-0 with 40 percent sulfur).

These combinations have been found to be very effective in controlling both the boll weevil and the bollworm, and with the

addition of the sulfur, add control for the red spider.

In the process, a quantity of 36 percent gamma isomer benzene hexachloride is first melted in a vessel equipped with a steam coil or jacket. The correct proportion of DDT is then added and melted in with mild stirring. The molten mix, containing approximately 62½ percent BHC and 37½ percent DDT, has the advantage that at room temperature it will not solidify for 72 hours.

An absorptive carrier is then impregnated by spraying with this melt to make a nine percent gamma BHC-15 percent DDT concentrate. This concentrate is then usually blended with twice its own weight of non-absorbent extender for 3-5-0, or sulfur and extender for 3-5-40.

The process was developed by Pennsalt's Research and Development Division and process equipment was designed by the company's Central Engineering Department. While the company is using the process in its own formulating plants, it is also being made available to other formulators.

The equipment necessary is described as being quite simple and can be adapted readily with minor changes to many impregnating and blending systems now in use.

Pennsalt of Washington Names Siddall

The Pennsylvania Salt Manufacturing Company of Washington has named Cameron Siddall assistant sales manager for agricultural chemicals in the eleven western states it was announced from Tacoma by William J. F. Francis, Pennsalt Western Agricultural Chemicals Sales Manager.

Mr. Siddall will continue to make his headquarters in Pennsalt's district offices in the Woolsey Building, 2168 Shattuck Avenue, Berkeley, California, where he has been serving as district manager for technical service and sales of agricultural chemicals for California, Arizona and New Mexico.

Dr. J. W. Brooks Joins Commercial Solvents

Dr. James W. Brooks has joined the Agricultural Chemicals Division of Commercial Solvents Corporation in charge of feed, insecticide, and fertilizer sales in the Central States, it was announced by Daniel B. Curll, Jr., Manager of the Division. He will make his headquarters at the Terre Haute office of the company.

Dr. J. W. Brooks

Prior to joining Commercial Solvents, Dr. Brooks was Manager of the Agricultural Chemicals Division of N. S. Koos and Son Company. He has had extensive sales and research experience in the feed, insecticide, and fertilizer fields, including state experiment station work. During the war, Dr. Brooks was in charge of a malaria unit of the Sanitary Corps in the Pacific.

A graduate of the University of Wisconsin with a Ph.D in economic entomology, Dr. Brooks is the author of more than a dozen papers, principally on the subject of chemical control of insects.

Niagara Chemical has signed a contract for construction of a new insecticide plant in Pecos, Texas. It will be a steel and concrete structure with gabled roof, containing 10,000 square feet of floor space. While main offices are in Niagara, New York, negotiations were conducted by the Harlingen, Texas, offices.

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CULTIVATION NEEDED FOR GOOD GROWTH

CONNECTICUT AES

The increasing dependence upon chemicals for controlling weeds in agricultural crops has tended to mean less use of the cultivator for this purpose, but experiments at The Connecticut Agricultural Experiment Station during the past three years show that the cultivator is not ready for retirement. Results show that, aside from its merits in destroying weeds, cultivation definitely steps up crop production.

According to Dr. C. L. W. Swanson and H. G. M. Jacobson of the Station's Soils Department, soil on cultivated plots showed improved structure and better aeration than that on plots treated with the chemical weed killer, 2,4-D. The better aerated soil released more nitrogen to the plants which produced a larger yield.

The test crop used was corn. On one-half the plots, 2,4-D was used exclusively for weed control. On the other half, cultivation was relied on to take care of the weed problem.

Results were particularly striking during the 1948 and 1949 seasons, both hot, dry summers, interspersed with infrequent, but heavy downpours of rain. On the 2,4-D plots, undisturbed by the cultivator, a hard crust formed, while the soil on the cultivated plots was porous and in good condition. More striking than the variation in soil, however, was the contrast in the crop grown. The corn on the 2,4-D plots was smaller and lighter green in color. At the end of the 1948 season, the cultivated plots yielded 61.5 bushels of corn per acre, while the plots treated with 2,4-D produced only 15.2 bushels. Corresponding figures for 1949, when weather conditions were somewhat more favorable, were 94.6 and 68.3.

Yield differences were much less pronounced in 1950, which was an ideal year for corn production. All plots did well, with the area trated with 2,4-D producing only 15 bushels less per acre than the cultivated plots. However, measurements of nitrogen in the harvested corn grain showed that the cultivated corn contained substantially more nitrogen than that receiving 2,4-D treatments. It is known that protein content increases directly as nitrogen content increases, so the food value of the cultivated corn was greater.

While the experiments were not designed to compare the efficiency of the two methods in controlling weeds, but only their effect on crop growth and soil tilth, observations did show that weed mortality on the 2,4-D plots was lower.

Despite the favorable results with cultivation, however, there is some evidence that it can be overdone. Soil examination of the corn plots under continuous cultivation for three years showed, that in areas where the tractor wheels had travelled many times, structure was poorer than in the spots where the wheel did not strike. Plans are to continue these experiments for several more years to see just how deleterious this compacting effect is on the soil and on crop growth.

From the past three year's work, it would appear that in hot years with rains which are very heavy when they do occur, cultivation is essential. In years when weather conditions are more favorable for crop growth, some cultivation will give better results than reliance upon chemical weed-killers alone. Probably the answer will be a judicious use of both methods of weed control, with the proportion dependent upon growing conditions.

Urges Farm Machinery Conservation

Secretary of Agriculture Charles F. Brannan has urged American farmers, with the aid of industry, to keep their farms in good shape mechanically to meet the Nation's defense food needs by conserving farm machinery and equipment and repair parts.

In connection with agriculture's defense job, Secretary Brannan said, "One of the first and most vital requirements of farmers today is for an adequate supply of production tools. This is demonstrated clearly by the fact that mechanization has been a key factor in the development of the vast productive capacity

of our farms. We must assure the Nation that our farm producing ability will not be impaired. The need to consider how we can maintain an adequate supply of farm machinery and equipment is on us now—since food demand for the 1951 crop year is heavy. And we must look to the future, when food needs may be even higher.

"An essential aid in keeping our farms in good condition mechanically is for the farmers to take all steps possible toward keeping their machinery and equipment in a constant state of repair and to use it under conditions that will cause the least wear. In the interest both of maintaining an adequate supply of farm mechanical equipment and of obtaining the food we shall need in the national defense effort, I fully recommend such measures."

The Department urges farmers to survey their individual needs now and place their orders, particularly for repair parts, as quickly as possible. The industry, it is hoped, will increase the output of repair parts and other items needed by farmers in the efficient maintenance of farm machinery. Manufacturers, of course, will be in better position to satisfy these requirements if farmers will "get their orders in" early.

The Office of Materials and Facilities of the Department's Production and Marketing Administration emphasizes the special need for careful handling and conservation of farm machinery which arises from the increased mechanization of farm operations in the past 10 years.

Farm production has increased 20 percent since 1941, with the aid of mechanization, while the labor force has dwindled since 1941 by about one million workers. This means that farm workers must be skilled to use the mechanical equipment on farms, and that the equipment is essential in sustaining full production of food and fiber. Machine operations on the farm are illustrated by the following examples:

While it is fortunate American farmers are better equipped than ever before with farm machinery and other mechanical facilities, this also makes farmers more dependent on the products of industry. For most farms, it is now a case of machinery or nothing.

Defense requirements may tend to limit the further expansion of farm mechanization, every effort should be made—to maintain the existing strong productive capacity of American agriculture.

	1941	1950
Tractors	1.7 million	3.8 million
Trucks	1.1 "	2.2 "
Milking Machines	210,000	710,000
Combines	225,000	650,000
Mechanical Corn Pickers	120,000	410,000

MANAGEMENT INSTITUTE LISTS "COMPANY MANNERS" FOR INDUSTRY

A list of "Company Manners," to help corporations show themselves in the best light for public, institutional and governmental appraisal, is being issued to its fellows by the American Institute of Management.*

Forty - four specific admonitions are presented in the document, with the observation that "No corporation can hope to flourish, or win public esteem for its products, unless it conducts itself properly. It must always be on its best behaviour and respect the rights and privileges of other members of our society. Even the most adroit public relations program can only repair damage if the general activities of the company do not command respect."

Willingness to volunteer executive manpower to emergency government agencies is emphasized as one attribute of "Company Manners" in the A.I.M. report. "Every responsible officer of a leading corporation should be willing to take leave of absence for such purpose," it declares. "In understanding such a mission, he must subordinate his company's interest to the national need and he must even favor competitors over his own company if by so doing he can procure a better product or save money for the government, or a better flow of needed materials."

Active participation in community affairs is another hallmark of good "company manners", the management group avers, remarking. "Although many managements do not realize this, the public demands genuine concern, in the part of corporations, for the public welfare. The larger the company, the more insistent this demand. Managements out of sympathy with this requirement are out of step with the times."

Management's relations with stockholders, employees suppliers and customers are covered in the report. Toward the first group the Institute recommends recognition that every shareholder is a co-employer of the company's officers; that investors in the firm's securities should be hospitably received by a responsible officer—not some junior executive — if they visit the home office in search of information; that full answers should be given to their inquiries, and that quarterly statements of earnings and assets should be in full detail, as opposed to "bare reports of sales and net income."

"Low dividend years are not the time to ask stockholders to approve bonuses or salary increases to incumbent officers," the report comments. "A company which has omitted dividends on any class of stocks during the current fiscal period, or whose current dividend is substantially below the average for its industry" should not indulge in elaborate and expensive annual reports.

"Company Manners" toward

* Copies of the report may be obtained from the American Institute of Management, 50 Washington Mews, New York 3, N. Y.

employees, the Institute points out, involve such factors as filling all possible promotions from within the company, maximum utilization of the handicapped, joint contributory benefit plans, detailed informative statements about such projects; formal grievance machinery; advance clearance of proposed incentive systems by the employees through their representatives, and full information on such matters as changes in product design, the introduction of new products, the progress being made with research, etc.

"It is good company manners to refrain from exhorbitant demands upon suppliers," the Institute declares, particularly as to quantity and timing of shipments during periods of threatened shortages or rising prices. The big buyer should not badger the small supplier under implied threats of withholding patronage if its requests are not heeded. It is grossly unfair to compress large orders into an unreasonably short space of time.

"Free technical assistance should be made available to dealers and distributors attempting to secure bulk orders, and also to suppliers struggling with production problems affecting their deliveries to the company. It is good company manners to pay all bills promptly and to help commercial customers obtain bank credit on satisfactory terms.

"Decent management," the report concludes, "does not demand significant price reductions from suppliers until it is convinced, and can demonstrate, that cost reduction is correspondingly possible. But, without being asked, it always passes on to its own customers at least part of its own savings."

Ammonia Storage Studied By Standards Association

Organization of a project on storage and handling of anhydrous ammonia and ammonia solutions has just been approved by the American Standards Association. This project was recommended at a recent conference of groups concerned with the manufacture, distribution, and use of this chemical. The Conference was called as a result of a request from the Com-

pressed Gas Association. The CGA has been approved as sponsor for the project under the procedure of the American Standards Association.

The scope of the project as approved by ASA covers: "Safety standards pertaining to the design, construction, location, installation, and operation of anhydrous ammonia systems, and transportation and storage of anhydrous ammonia, and ammonia solutions, but not pertaining to ammonia manufacturing plants, refrigerating or air conditioning systems."

The thirty-two organizations to be invited to participate in the work of this project are:

Agricultural Ammonia Institute, American Society of Agricultural Engineers, American Society of Mechanical Engineers, American Municipal Association, American Society of Refrigerating Engineers, American Trucking Association, American Institute of Chemical Engineers, American Society of Safety Engineers, American Water Works Association, Associated Factory Mutual Fire Insurance Companies, Association of Casualty and Surety Cos, Accident Prevention Dept. Bureau of Explosives, Building Officials Conference of America, Inc., Bureau of Labor Standards, U. S. Department of Labor, Compressed Gas Association Inc., Council of State Governments, Department of the Army, Department of the Navy, Bureau of Ordnance, Department of Agriculture, Federal Interdepartmental Standards Council, International Association of Governmental Labor Officials, Interstate Commerce Commission, Bureau of Motor Cariers, Interstate Commerce Commission, Bureau of Service, Manufacturing Chemists' Association Inc., National Association of Mutual Casualty Cos, National Board of Fire Underwriters, National Council of Private Motor Truck Owners, National Fire Protection Association, National Safety Council, Refrigeration Service Engineering Society, Synthetic Organic Chemical Manufacturers Association, U. S. Coast Guard.

Standards developed under the procedures of the American Standards Association have to be agreed upon by all who are substantially concerned with the problem and with the scope and provisions of the standards. The consensus principle extends to the initiation of the work under ASA procedure, to the method of work to be followed, and to the final approval of the standard.

Fish Story Sequel

GEORGE E. PETITT
50 BROADWAY
NEW YORK, N. Y.

February 13th, 1951

Dear Reds:

On my return to the office this week, after a full week's absence, I find your very kind and most interesting letter of January 24th, bestowing upon me, through yourself, the honorary degree of "M. A. Piscatorial, Cum Louder and Funnier" in recognition of the measurable efforts which I, from time to time, have made in pursuing the sciences of the "Great-Out-of-Doors."

Under separate cover, I was delighted to receive the framed diploma as an emblem of this honor. Naturally, I accept this great honor with considerable reluctance. Paraphrasing Mr. Churchill, I can only say that never in the annals of human events has so much been granted for so little attained. However, in accepting this honor, in spite of the trifling attainments in this field of activity, I do so with a pledge sincerely made that I shall continue to strive eternally in this particular field of endeavor, with the hope that ultimately I may reach the point where I can truthfully feel that I have earned this recognition.

I assure you that this diploma will be prominently displayed on the wall of my new office in Washington, when we get there, so that all who come to visit may see for themselves the rewards which can be expected to come to one who pursues at all times a clean and wholesome outdoor life.

Hoping that this finds you and yours enjoying the very best of health, and with warm personal regards, I am

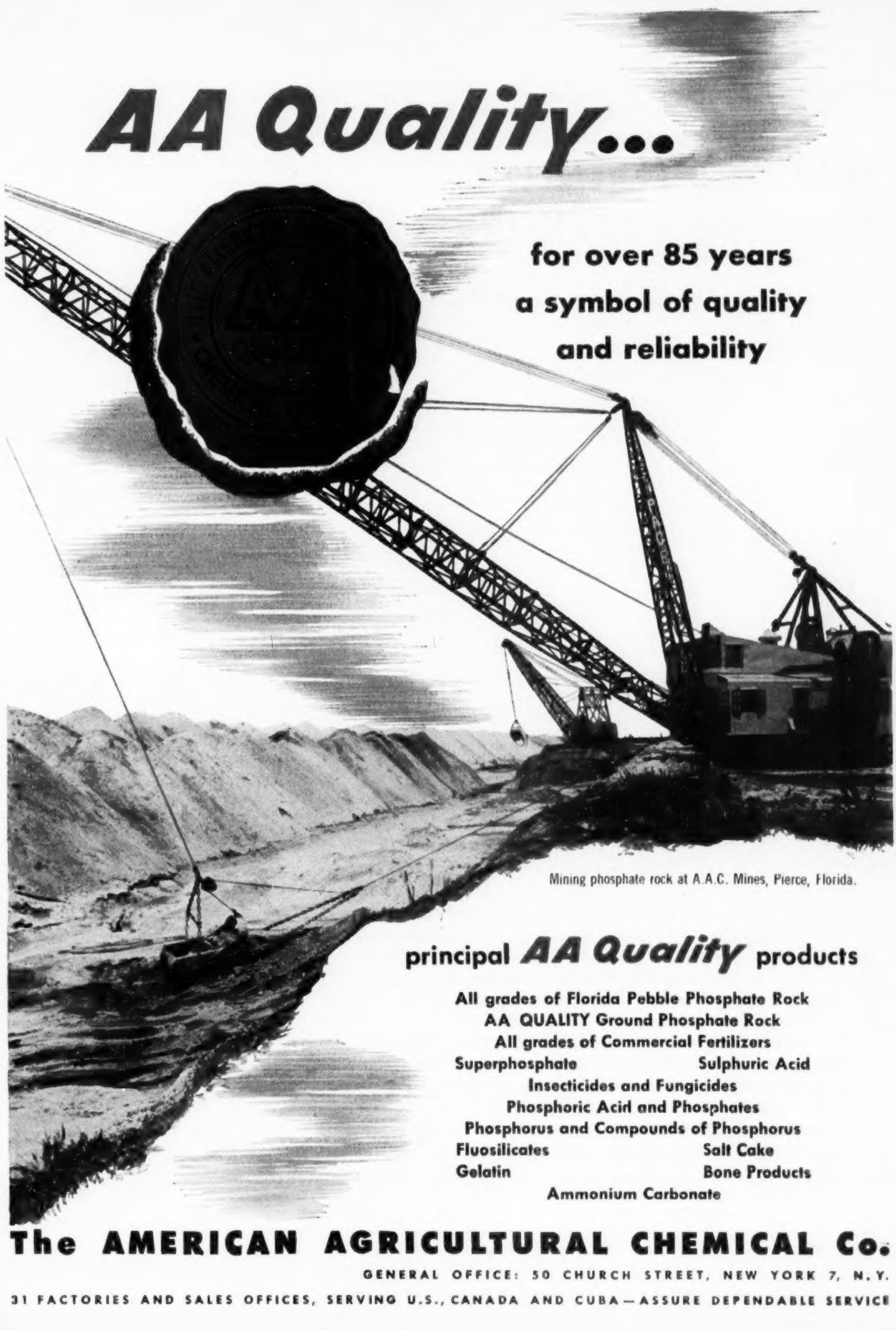
Sincerely yours,
Geo.

GEP:N
Mr. Travis S. Whitsel
400 North Franklin Street
Chicago, Illinois

FFA Meeting
Houston, July 11-13

The Future Farmers of America, Texas Association, named Houston as the site of their 1951 convention at an executive meeting held in Dallas recently. This year's convention, said Weldon Mason, Meadow, Texas, president of the 34,000-member Texas organization, will be the largest and most elaborate in the F. F. A.'s quarter of a century in the state. Headquarters for the conclave will be the Shamrock Hotel and the date set is July 11-13.

July's convention — number twenty-three for the Texas Association — will feature the participation of major national firms dealing in the farm market.



Mining phosphate rock at A.A.C. Mines, Pierce, Florida.

SOUTHERN FERTILIZER PLANS BIG EXPANSION

A. D. Strobhar, president of the Southern Fertilizer and Chemical Company, Savannah, Ga., has announced that his company is starting work immediately on an expansion program which will involve an expenditure of approximately a third of a million dollars. The new facilities will be located adjacent to their present plant on Hutchinson Island and the first unit will be a contact sulphuric acid plant of the very latest design.

Mr. Strobhar said "this development is the outcome of intensive studies extending over the past five years and signifies our return to the chemical manufacturing field. We have been hiring and training technical personnel and our staff now includes three chemical engineers and three mechanical engineers who are well qualified to supervise this expanded program. They are continuing market studies to determine what additional chemical products are best suited for production in the Savannah area and we expect not only to expand and diversify our production but to extend our market area within this country and in the export field."

Mr. Strobhar advised further that contract has been let for the new equipment and for supervision of the job to the Nicolay Titlestad Corporation of New York City who are outstanding specialists in this field. They expect to get started as soon as the necessary foundation work is completed. This phase of the job will be performed by a local contractor and the actual start will be made as soon as he has the necessary pile driving equipment available. Present plans call for the first unit to be in operation by November 15, 1951.

Allen D. Brent, production manager for Southern Fertilizer and Chemical Company, who has been supervising the expansion plans added a few technical details. He said "the new contact sulphuric acid plant will replace our present lead box chamber plant which was built in 1916 and will increase our production by 65 per cent. With the new plant we will produce technical grade 98.5 per cent sulphuric acid. This high strength sulphuric can be converted into 66°, 60° baume, or any of the other popular trade acids. We will be in position to compete for the sulphuric acid requirements of a wide variety of industries now located in the region and will be prepared to expand and diversify our production to supply inorganic chemicals to new industries which may consider locating in Savannah.

"Specifically—we already have facilities for storage and use of Anhydrous Ammonia and can offer Fluosilicic Acid as a by-product of our Superphosphate production. Thru the Stagson Research Corporation of Charleston, S. C., we are participating in a cooperative research program on the development of fertilizer materials and inorganic chemicals. We have already progressed to a point where we are ready to install equipment to produce nitric acid and hydrochloric acid as soon as our market research shows the need. When this is undertaken an expenditure of an additional $100,000 will be required. With these acids as basic chemicals, we will be in position to manufacture many other inorganic chemicals and we are prepared to diversify just as fast as markets can be developed.

"Along with the plans for these additions, we have been constantly improving our present operations. In recent years

The new wheel tractor loader, featuring hydraulic torque converter drive being offered by Tractomotive Corporation, Deerfield, Illinois. It is known as the TL-10 Tracto-Loader, and our readers should ask for data on it by this name when writing the company.

we have almost completely mechanized our materials handling operations. This has largely eliminated seasonal fluctuations and has practically stabilized our employment at our two plants and general offices in Savannah. We are operating one of the most modern and efficient plants in the industry and are providing steady, year round employment far in excess of 150 people."

When questioned regarding the history of Southern Fertilizer and Chemical Company, Mr. Strobhar pointed out that it always has been and still is strictly a Savannah enterprise. He said: "I organized the company in 1905 together with Murray Stewart and J. J. Rauers and the cotton factoring firm of Canon and Barnwell. We were joined in 1915 by W. Dewey Cooke, who is now our vice president. Our first operation was a dry mixing plant located in warehouse space leased from the Seaboard Railroad. We soon outgrew this and in 1909 constructed our first acidulating plant at our present location. Sulphuric acid was obtained from Copper Hill, Tennessee, until the outbreak of the first World War created a shortage of this material. It became necessary for us to enter the acid production field, and in 1916 we constructed the lead box chamber plant which will be dismantled when the new contact plant is placed in operation this fall.

"In the spring of 1918 our original acidulating plant burned, but it was replaced immediately by the modern crane type plant which is still in use."

Around the Map

ALABAMA

Mathieson's Alabama Chemical Corporation has started construction of a $10,000,000 chlorine and caustic soda plant near McIntosh, at a giant salt dome.

ARKANSAS

Lion Oil Company was asked, in a resolution by the Arkansas House of Representatives, to give priority on nitrogenous fertilizer to the farmers of Arkansas.

* * *

Diamond Alkali Company, Pine Bluff, has signed a 10 year lease with the Government for its plant there, and will expand its chlorine-caustic-soda plant 30%, ready by August, reports Superintendent **T. S. DeWoody, Jr.**

GEORGIA

Southern Fertilizer and Chemical Co., Savannah, has begun a $350,000 plant expansion program, according to **A. D. Strobhar**, its president. See story elsewhere in this issue.

FLORIDA

Florida Fuller's Earth Mining Co., Quincy, reputed to be second largest in their field, suffered a $100,000 fire in mid-March when a conveyor belt burned in two and set fire to the elevator, according to **C. L. Sowell**, manager.

* * *

Armour Fertilizer, Bartow, is reported to have been awarded a tax benefit of $1,975,500 for industrial expansion. The plant involved is already in operation, producing triple superphosphate.

ILLINOIS

Central Illinois Fertilizer Co., Tuscola, has been chartered with 500 shares of $100 par value stock, to deal in commercial fertilizer in liquid or dry form, chemicals, sprays and allied equipment. **Harley C. Helm** is listed as correspondent.

MARYLAND

Wm. B. Tilghman Company, Salisbury, as we have reported here occasionally in the past, publish a house organ known as "The Tiller." In the most recent issue to reach us they modestly mention, as a minor item that their plant has been thoroughly modernized. "A new railroad spur" they report, "runs into the plant, and in addition a complete new shipping and bagging unit with the latest in modern machinery, has been installed."

The editorial content of this little paper is varied. For example an editorial about "Billy" who started with a heifer and now has a herd valued at $3,500. The Tilghman outfit encourages such youth activity, and we have previously reported on their prize awards.

Also in the recent issue was an editorial, which is well worth quoting in full:

"FERTILIZER:

for Production . . . Defense . . . Prosperity . . . Conservation

"Much of America's farm production comes from fertilizer use. Our standard of living, the highest en-

joyed by any nation, depends largely on fertilizer. Its use assures adequate supplies of high quality foods and fibers for a constantly increasing population.

"In war or peace, fertilizer is a vital factor in the strength of our Nation.

"It is farmer's best investment. $1.00 spent for fertilizer returns an average of $6.80 in farm products Fertilizer prices are low. Since 1939 over-all prices paid by farmers have risen 107%. Prices received by farmers have risen 164%. Fertilizer prices have gone up only 43%. Fertilizer use promotes farm efficiency, cuts production costs.

"With fertilizer, poor soils can be put to profitable use. Worn-out soils can be reclaimed. All soils can be made more productive. Fertilizer use prevents soil depletion, soil erosion, soil abandoment. It makes every acre count.

"Born in Baltimore a century ago, the fertilizer industry has spread to every State in America. Nature's raw materials for making the plant food needed by farmers to grow their crops and conserve their soils, are drawn from the air above, from the earth's surface and from the riches buried deep below."

MISSISSIPPI

Spencer Chemical Company, Kansas City, has announced a further expansion of anhydrous ammonia facilities at its Jayhawk Works. We have already reported their acquisition of the ammonia plant at Henderson, Kentucky. The total of all this will mean a doubling of their ammonia capacity over their figures for June, 1946.

* * *

Mississippi Chemical Corporation, Yazoo City, expects production by early Spring, if construction continues on schedule. Strikes among equipment fabricators has delayed opening three months. **Owen Cooper**, executive vice president, has urged stockholders to get their 1951 requirements elsewhere.

* * *

South Mississippi Manufacturing and Engineering Company, Poplarville, has announced the first fertilizer application service in the Tung Belt. Specializing on anhydrous ammonia, they can serve 100 acres per day.

MISSOURI

Business men of Malden will undertake the financing of a $50,000 fertilizer plant. **Ark-Mo Plant Foods** is considering the establishment of a plant in Malden and the local citizens feel that financing the structure will assure them of the development which could bring in a payroll of $200,000 a year. Ark-Mo has a plant at Walnut Ridge, and is building another now at West Memphis, Arkansas.

NORTH CAROLINA

B. C. Gaddy Company, Monroe, suffered a $30,000 fire, only partially covered by insurance, which included fertilizer recently shipped in.

SOUTH CAROLINA

Etiwan Fertilizer Company, Charleston, are replacing the plant destroyed in a million dollar fire last December. $50,000 will be devoted to the plant construction, the original loss largely representing materials stored in the burned structure, and freight cars being unloaded.

TENNESSEE

Western Fertilizer Co., Muleshoe, in mid-March, sponsored a fertilizer meeting showing farmers color movies, offering entertainment and refreshments, in addition to the basic talks by experts.

CANADA

Bata Petroleums, Ltd., Regina, Saskatchewan, has been issued a permit for exploration and development of potash in Canada. The permit covers 100,000 acres of the Unity District and the development program will cost $235,000 over the next three years. Brine mining will probably be used, due to the depth of the deposits which make shaft mining impractical.

The **Advisory Fertilizer Board** of Ontario recommended to all fertilizer manufacturers in the province that the manufacture and sale of low analysis fertilizers such as 0-14-7, 4-8-10, 9-5-7 and 2-12-6 be discontinued with the completion of the 1951 spring business. This decision was announced by the secretary, **A. H. Martin**, following a recent meeting of the board in Toronto. As all these analyses contain filler to a greater or less degree, the rising costs of transportation, labor and bags make it less economical for the farmer to buy fertilizers of that type.

Already two of these, 0-14-7 and 9-5-7, have pretty well disappeared from the market, 2-12-6, however, is still the most popular fertilizer in Ontario. Two higher strength fertilizers, 3-18-9 and 4-24-12, one and one-half times and twice the strength of 2-12-6 respectively, have been introduced recently and are now available.

44% More Money For Bigger Cotton Acreage

Cotton farmers are using the facilities of their local production credit associations to help them finance the increased cotton acreage called for by the U. S. Department of Agriculture, according to reports received from the 15 cotton States. "In the 3-month period, November 1950 through January 1951, members borrowed 44 percent more money to raise cotton than they did in the same period a year ago," I. W. Duggan, governor of the Farm Credit Administration, reports.

The number of cotton loans in the 15 States was up only slightly, but the amount increased $12 million, indicating that individual farmers are planting more acres to cotton in their effort to help up the cotton acreage from 18.6 million acres last year to 28.5 million acres.

ADVISORY COMMITTEE

(Continued from page 19)

necticut, M. G. Field, Meridian Fertilizer Factory, Hattiesburg, Mississippi, George W. Gage, Anderson Fertilizer Co., Inc., Anderson, South Carolina, E. A. Geoghegan, The Southern Cotton Oil Co., New Orleans, Louisiana, J. Ross Hanahan, Planters Fertilizer & Phosphate Co., Charleston, South Carolina, Charles E. Heinrichs, Virginia-Carolina Chemical Corp., Richmond, Virginia, Cecil A. Johnson, Agricultural Products Co., Webster City, Iowa, B. H. Jones, Sunland Industries, Inc., Fresno, California, M. H. Lockwood, International Minerals & Chemical Corp., Chicago, Illinois, Ray E. Neidig, Balfour-Guthrie & Co., Ltd., San Francisco, California, J. Elam Nunnally, The Cotton Producers Association, Atlanta, Georgia, John R. Riley, Spencer Chemical Company, Kansas City, Missouri, Walter S. Rupp, Baugh & Sons Company, Baltimore, Maryland, John E. Sanford, Armour Fertilizer Works, Atlanta, Georgia, C. D. Shallenberger, Shreveport Fertilizer Works, Shreveport, Louisiana, John W. Sims, The Farm Bureau Coop. Assn., Inc., Columbus, Ohio, Mac C. Taylor, Oregon-Washington Fertilizer Co., Seattle, Washington, Fred T. Techter, Allied Chemical & Dye Corporation, New York, N. Y., James E. Totman, Summers Fertilizer Company, Baltimore, Maryland, W. N. Watmough, Jr., Davison Chemical Company, Baltimore, Maryland, Fred J. Woods, The Gulf Fertilizer Co., Tampa, Florida. (Horace M. Albright, U. S. Potash Co., New York, N. Y., was unable to attend but was represented by J. E. Barnes).

Other members of the committee, who were unable to attend the meeting are:

James D. Dawson, Jr., Fidelity Chemical Corp., Houston, Texas, John A. Miller, Price Chemical Co., Louisville, Ky.

The following representatives of trade associations attended as observers:

Dr. Russell Coleman, National Fertilizer Ass'n., Washington, D. C., Paul T. Truitt, American Plant Food Council, Washington, D. C., Dr. H. B. Mann, American Potash Institute, Washington, D. C.

Agronomists: IN MIDWEST THEY TALKED PASTURE FERTILIZATION

By Z. H. BEERS

New research developments in pasture fertilization and management were described by soils specialists attending the annual meeting of Midwestern agronomists and fertilizer industry representatives in Chicago. The meeting was sponsored by the Middle West Soil Improvement Committee.

The program was conducted by the agronomists, with Dr. Garth W. Volk of Ohio State University, presiding as chairman. Registrations exceeded 220, including soils men from 13 Midwestern colleges, representatives of the U. S. Department of Agriculture, the American Society of Agronomy and industry men representing companies in the fertilizer, farm machinery, supplies and equipment field.

Dr. D. R. Dodd, extension agronomist, Ohio State University, reported on a 1950 pasture survey covering 31 states, with special emphasis on the Corn Belt. The concensus of opinion among Midwestern agronomists, he said, is that "much more general, frequent and liberal fertilizer applications should be used on sod lands east of the range area." Convenience of application is as important as any other factor in adding fertilizer to sod land under average conditions, he said. It is more important to get the fertilizer on to the soil than to apply it at any particular time of year. Fertilizer gives much the same return on pastures whether added in the spring or fall. This is particularly true in Eastern areas of the Corn Belt.

Citing research in Indiana and Illinois, Dr. G. O. Mott, of Purdue University, said that phosphate deficiencies are more often the growth of legumes than any other fertilizer element. He warned, however, that "if we continue to mine potash from our soils, eventually a deficiency of potash will put a limit on the production of forage legumes on many soils." He reported average increases of 71 pounds of beef per acre on legume-grass pasture limed and fertilized with phosphate and potash. Adding nitrogen to phosphate-potash fertilizer boosted beef production 111 pounds per acre in further tests. Mott said that for maximum beef production, grass pastures fertilized with nitrogen should be stocked with sufficient cattle in the spring and fall to make use of the extra grass produced in those seasons.

Reporting on pasture fertilization in Kansas, North and South Dakota, Kling L. Anderson of Kansas State College said that both forage and seed yields are boosted considerably by the use of nitrogen fertilizers. Old grass stands on depleted lands need phosphate fertilizers as well as nitrogen, he said. Phosphate fertilizers, he added, speed the establishment of cool season grasses and legumes.

Dr. R. L. Cook, of Michigan State College reported that adding fertilizer is a profitable investment even on highly productive heavy soils. Alfalfa yields were boosted 1,800 pounds per acre in Michigan tests when the pasture was top-dressed with 300 pounds of 0-16-8. Hay yields were increased by 1,200 pounds per acre on an old alfalfa stand on Miami silt loams when 400 pounds of 0-16-8 fertilizer was applied with a grain drill on April 8. Michigan experiments, he said, have shown that it is essential that new legume seedings, particularly alfalfa and clover, should be accompanied by liberal applications of phosphate-potash fertilizers.

Dr. E. N. Fergus, University of Kentucky agronomist, reported that field tests in Kentucky and Missouri indicate that soil nutrient deficiencies are similar in both states. Recommended treatments are thus similar in the two states. In Kentucky, he said, agronomists recommend the equivalent of 300 to 500 pounds of 0-14-7 per acre in alternate years for permanent pastures outside the Central

Bluegrass region. One ton of ground limestone is recommended each eight to 10 years.

Prof. Paul M. Burson, University of Minnesota agronomist, reported on pasture fertilization research conducted by soils specialists in Minnesota, Iowa and Wisconsin. Proper fertilization, better grazing and pasture management, he said, offers the best means of cutting costs of livestock production and boosting profits. Well-managed, fertilized pasture and meadow crops, he said, will: (1) Improve the soil; (2) Increase productivity; (3) Prevent erosion; (4) Stabilize production; and (5) Improve farm income and family living over a period of years. "Pasture and meadows," he said, "are crops the same as corn and grain. And they respond to proper soil treatments and good management the same as other crops."

Dr. Russell Coleman, president of the National Fertilizer Association and Mr. Paul T. Truitt, president of the American Plant Food Council discussed the fertilizer supply situation and the outlook for the months ahead.

A question and answer period on Friday afternoon followed the presentation of the agronomists' reports. Dr. Volk then presented the agronomists' 1951 fertilizer recommendations for Midwestern states. This included the suggestions by various state agricultural colleges of fertilizer grades for their particular states for the year beginning July 1, 1951.

In addition to those presenting papers, the following agronomists were present and took part in the discussion: Dr. F. C. Bauer and Prof. A. L. Lang, University of Illinois; Dr. K. C. Berger, Prof. C. J. Chapman and Prof. Emil Truog, University of Wisconsin; Dr. H. B. Cheney and J. W. Fitts, Iowa State College; Dr. E. R. Graham and Prof. Arnold Klemme, University of Missouri; Dr. P. E. Karraker, University of Kentucky; Dr. F. D. Keim, Dr. H. F. Rhoades, and Dr. M. D. Weldon, University of Nebraska; Dr. John M. MacGregor, University of Minnesota; Dr. William P. Martin, Ohio State University; Dr. H. E. Myers and Dr. Floyd W. Smith, Kansas State College; Dr. E. B. Norum, and T. E. Stoa, North Dakota State Agricultural College; Dr. A. J. Ohlrogge and Dr. J. B. Peterson, Purdue University; Dr. Leo F. Puhr and Dr. W. W. Worzella, South Dakota State College; and Dr. L. M. Turk, Michigan State College.

500 went on NFA's tour in South Carolina

IN SOUTH CAROLINA THEY TOURED PASTURES TO OBSERVE WINTER GRAZING

Those who were fortunate enough to attend the winter grazing clinic, sponsored by NFA's Plant Food Research Committee, and the Extension Service of South Carolina, went home with new enthusiasm. They have no fear that cold winters spell the end to winter grazing, for they have seen firsthand that good practices bring pastures through with flying colors.

The members of the clinic have come up with a recipe to insure success. It is a five-point program and the officials from the various States in attendance agree that it applies "straight across the board." Here it is:

1. Develop a plan, bearing in mind your livestock enterprise.
2. Prepare a good seedbed.
3. Lime as needed and fertilize heavily.
4. Seed early and heavy enough to insure a thick stand.
5. Use sound management, including rotational grazing to avoid overgrazing or undergrazing, and store for critical periods at least 1 ton of hay or 3 tons of silage for each animal unit.

Time and time again the group saw how good cultural practices and management paid off. Farmers who seeded heavy and early and fertilized well had growth before the cool weather set in, and this growth furnished grazing throughout the cold winter. On the other hand, farmers who delayed their seeding or those

who skimped on fertilizer and failed to prepare good seedbeds found that their pastures provided little or no grazing, and in many cases were killed-out by the cold weather. In a few instances cattle were able to go through the entire season without any dry feed, but those fed small quantities of hay or silage prospered best.

Yes, there is no secret to making winter grazing pay in good or bad seasons. As in other enterprises, management spells success or failure.

TREES

fertilizer is to supplement the native constituents rather than to constitute the only source of supply. They state that in order to prevent abnormal physiological developments, there should be a proper balance between the elements of nutrition; the proper fertilizer will aid in establishing this balance. The writers point out that proper fertilization is difficult because the microorganisms are influenced just as profoundly as are the higher plants. Even after soil analysis, the kind of fertilizer and the amounts to apply per acre are always somewhat of a guess. They also recommend the application of moderate amounts of fertilizer until the maximum paying quantity is ascertained.

Roth, Toole, and Hepting (1943) applied fertilizer to shortleaf pine in an effort to check littleleaf disease. The experiment was conducted on the Madison, Appling, Louisa, and Cecil soils in Alabama and on Madison, Louisa, Hayesville, and related soils on the General Pickens District of the Sumpter National Forest. The fertilizer was applied to dominant and codominate shortleaf pine between the ages of about 25 and 70 years. The results are based upon measurements or estimates of needle length, needle color, and shoot growth over the tree as a whole. Each treatment was applied to two 1/10 acre plots in March 1941. Fertilizers were broadcast over the surface of the ground on the plots and on a border isolation strip 17 feet wide.

The quantities of the carriers of major nutrients were as follows:

Major nutrients	Pounds per acre
P as superphosphate (16% P_2O_5)	1,000
K as muriate of potash (50% K_2O)	160
N as sodium nitrate (16% N)	200
ammonium sulfate (20.5% N)	200

The plots receiving nitrogen were given a supplemental nitrogenous dressing equivalent to the original amount at the end of one year, and all plots were treated again after two years. Where nitrate or ammoniacal nitrogen exceeded 200 pounds of nitrogen per acre the disease was checked and also showed increased needle length and shoot growth.

McComb (1949) studied the growth of green ash, American elm, red oak, and black locust seedlings in relation to nitrogen, phosphorus and potassium fertilization of four Iowa soils. The fertilizers were added to B and C horizon soil materials and growth compared with that obtained on unfertilized surface and subsoils. The experiment was conducted under field and greenhouse conditions. Nitrogen was found deficient for growth of ash, elm and oak. Black locust did not respond to nitrogen fertilization. It was also found that as the residual soil nitrogen supply increased, growth response decreased in magnitude. No nitrogen response was found when phosphorus was inadequate; when phosphorus was adequate a tremendous nitrogen response resulted. On the whole, the response to phosphorus was smaller than to nitrogen. Potassium was sufficient in all the soils causing little, if any response, when potassium alone was added. Responses in the field were not as great as under greenhouse conditions. This is most likely due to the higher fertility of field soils, and the fact that environmental conditions were controlled in the greenhouse experiments.

The Southeastern Forest Experiment Station is now conducting an experiment on the fertilization of loblolly pine seed trees; the problem is to produce adequate seed during the period when the seed is needed. The study will be carried on in 25 to 45 year old loblolly pine stands. A commercial fertilizer of formula 7-7-7 will be applied at the rate of 25 and 50 pounds per tree.

Plan Early For NFA Reservations

It is not too early to begin planning for the 26th annual convention of The National Fertilizer Association to be held June 11-13, 1951, at the Greenbrier, White Sulphur Springs, West Virginia.

Hotel accommodations are limited, especially as to single rooms. Therefore, if some of those who plan to attend, and whose wives will not accompany them would like to share rooms with others, it will help the hotel.

Reservations should be requested direct from the hotel and NFA is sending forms which they request that you use for that purpose to head offices of members, but will send forms to any address to which you would like them sent if you will request it. Also, if you need extra forms for your head office use, please write the Association.

The hotel requests that a separate form be used for each reservation requested. Use of the forms in making reservation requests will assure your requests having the hotel's best attention.

ARE WE *Replacing Soil*

When deep gullies appear in a field, it is easy to see that soil productivity is being lost.

When nutrients are lost from a soil, we lose soil productivity too, even though we can see no change at the time. This loss in soil fertility is not only serious in itself, but it contributes directly to soil erosion as well.

The loss of nutrients caused by leaching and soil erosion is difficult to evaluate, and it is much greater in some areas than in others. Nutrients are also removed from soils by harvesting crops, and the quantities removed in this way are relatively large in all farming regions.

In some regions the decomposition of soil minerals and organic matter replaces part or all of the nutrients removed in crops. Fertilizers and manure, however are the most important sources of added plant nutrients for the United States as a whole.

Nitrogen Removal Varies

Nitrogen removal in harvested non-legume crops varies from 15 pounds per acre in the South Atlantic region to 29 pounds in the New England region (see Figure 2, white bars).

The South Atlantic region, with the lowest average rate of nitrogen removal in crops, has the highest rate of addition in fertilizers—20 pounds of nitrogen per acre (Figure 2, black bars). On the other extreme, nitrogen additions in fertilizer average less than three pounds per acre in the East North Central, West North Central, West South Central and Mountain regions.

Total nitrogen applications in fertilizers and manures exceed removal in crops in the New England, Middle Atlantic and South Atlantic regions.* Figure 2 (hatched bars) shows that commerical fertilizers supplied most of the nitrogen added in four of the regions, while manure was the major source of nitrogen supply in the other five regions. For the United States as a whole, approximately two-thirds of the nitrogen applied to harvested crops is added as manure.

Only One-Half Replaced

Additions from manure and fertilizers combined replace only slightly more than half of the nitrogen removed in non-legume harvested crops.†

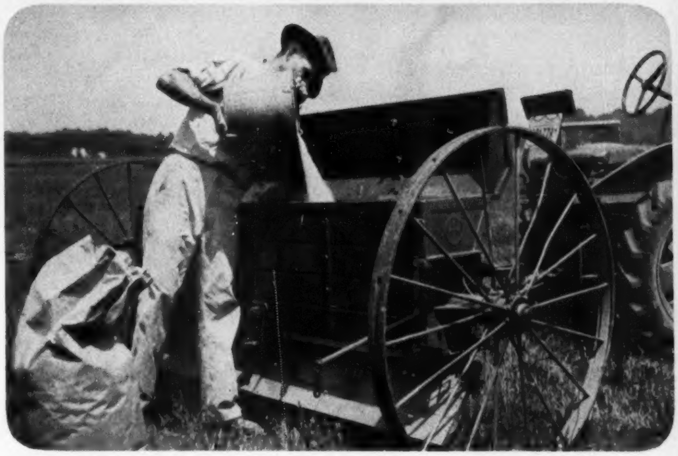
*These calculations of nutrient removal and additions are based on average values by states. Naturally, values for nutrient replacement are higher than average for some farms, farming areas and soil types; but lower than average for others.

†These calculations are based on the 100 most important non-legume crops. Removal of nitrogen in legumes is not considered, since most or all of this nitrogen was obtained from the air, and not from the soil. Additions to soil nitrogen by legume roots is not included in these figures, though it does represent an important addition in some areas and cropping systems.

Nutrients

By A. L. Mehring and R. Q. Parks in Crops & Soils

(Above) A 600-bushel crop of potatoes removes from the soil about 125 pounds of nitrogen, 50 pounds of phosphoric acid, and 180 pounds of potash. To maintain such yields, nutrients must be replaced.



(Top photo) Manure applications account for about two-thirds of the nitrogen applied to harvested crops in the U. S. (Below) Approximately two-thirds of the phosphate and one-half of the potash applied to crops is in the form of commercial fertilizers.

When additions are balanced against removal in crops (Figure 1), it is seen that more than 100 percent of the nitrogen removed is being replaced in the Northeastern and Southeastern states. Experiments indicate, however, that in humid regions the crop frequently recovers no more than 50 percent of the applied nitrogen. Some of this nitrogen may go into soil organic matter, but leaching losses are also sizeable. Consequently, a replacement of nitrogen of over 100 percent is not necessarily satisfactory.

On most farms in humid areas, more nitrogen in the form of manure, commercial fertilizers, and legumes could be used profitably in crop production.

Fertility Trends Shown

Calculations of percent replacement of nutrients are useful in pointing out trends in soil fertility levels, but should not be used in making fertilizer recommendations. There are some areas where less than 100 percent replacement of nutrients removed is quite satisfactory, and others where the most economical levels of fertilization are well in excess of 100-percent replacement.

The final measure of the quantities of nitrogen (N), phosphate (P_2O_5) and potash (K_2O) that should be applied by the farmer is the return he obtains from using them in a cropping

A. L. Mehring is senior chemist, Division of Fertilizer and Agricultural Lime, and R. Q. Parks is assistant head, Division of Soil Management and Irrigation; Bureau of Plant Industry, Soils, and Agricultural Engineering; U. S. Department of Agriculture, Beltsville, Md.

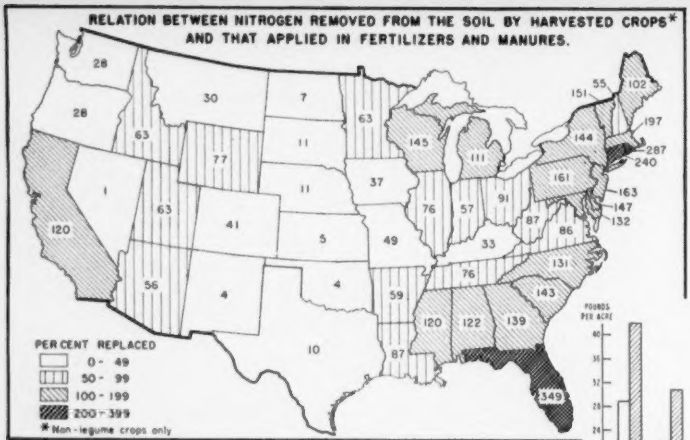
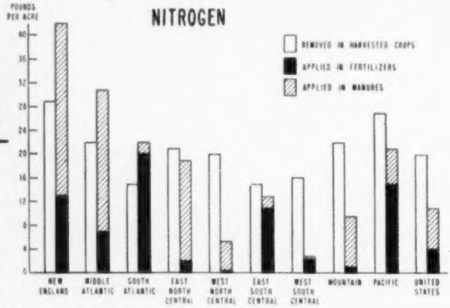


Figure 1 (left) shows the percent of nitrogen replaced in the various states, as compared to the amount removed by the 100 leading non-legume crops. (USDA)

Figure 2 (below) shows how the removal of nitrogen (per acre) compares with the amount applied as manure and fertilizers in the various areas of the U.S.A.



system that provides for sustained and efficient production.

Soils in the Mountain and Pacific regions are generally low in nitrogen and organic matter. Nitrogen applications are derived largely from manure in the Mountain region, and from commercial fertilizers in the Pacific region. Despite the use of large amounts of manure, together with the relatively large acreages of alfalfa and other legumes, replacement of nitrogen in the western regions is not high. As a large percentage of the agricultural land in these regions is under irrigation, an evaluation of nitrogen leaching losses would make the picture even less favorable. Recent crop experiments show that considerably larger amounts of nitrogen could be used in raising levels of production in this area.

Plains Soils Need Nitrogen

The least favorable picture of nitrogen replacement is shown in the Northern and Southern Great Plains states. This represents a problem of great agricultural significance, since the reserves of organic nitrogen stored up in the soils of these regions are being depleted.

Although lack of adequate moisture is still the chief factor limiting production in the Plains States, long-time experiments show that the response to manure during seasons of favorable rainfall is now greater than formerly. Excellent response to nitrogen fertilization is also being obtained in these areas with a number of grasses—particularly the early-season varieties. Unless adapted legumes are developed and worked into the cropping systems of the West Central States, it is probable that maintaining an adequate nitrogen balance will require the use of more fertilizer nitrogen.

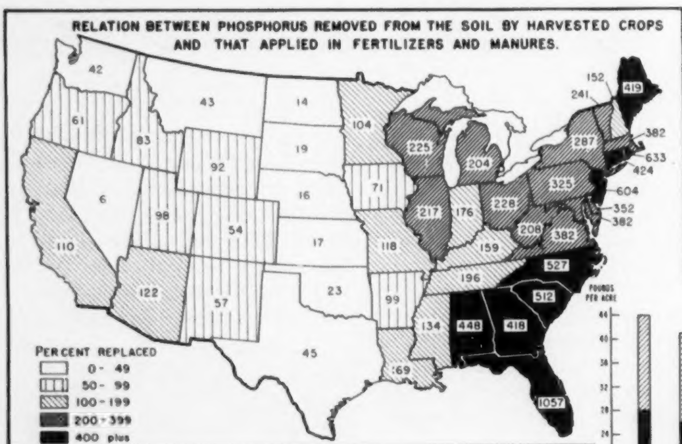
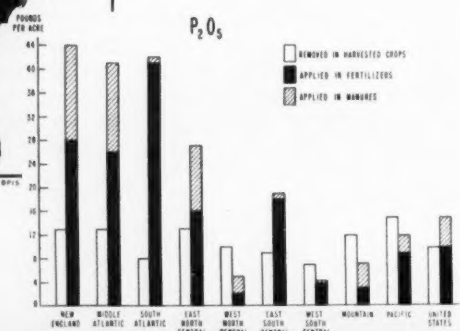


Figure 3 (above) shows the percent of phosphorus replaced in the various states, as related to removal of crops harvested.

Figure 4 (right) shows how the removal of phosphorus compares with amounts added as manure and fertilizers in various regions.



The Phosphorus Picture

Removal of phosphorus in harvested crops varies from seven pounds of P_2O_5 per acre in the West South Central region to 15 pounds in the Pacific region (Figure 4, white bars).

This is in contrast to P_2O_5 applications in fertilizer of 41 pounds P_2O_5 per acre in the South Atlantic region, and 26 and 28 pounds P_2O_5 per acre in the Middle Atlantic and New England regions (Figure 4, black bars). Only in the Mountain, West South Central and West North Central regions do applications of P_2O_5 in fertilizers average less than five pounds per acre.

Manure additions are insignificant compared to fertilizers in supplying phosphorus to soils in the South Atlantic, East South Central, and West South Central regions. In the New England, Middle Atlantic and East North Central regions, manure additions supply from 11 to 16 pounds of P_2O_5 per acre, but still do not equal fertilizers in supplying P_2O_5. Only in the Mountain and West North Central regions is more P_2O_5 added by manure than by fertilizers.

Phosphorus Replacement High

For the United States as a whole, P_2O_5 additions are greater than removal in harvested crops by 40 percent. Fertilizers supply slightly over two-thirds of the P_2O_5 added.

For the eastern United States, replacement by fertilizers and manures of P_2O_5 removed in harvested crops varies from 200 percent in the East North Central region, to nearly 500 percent in the South Atlantic region (Figure 3).

The percentage of applied P_2O_5 recovered is generally quite low as contrasted with the recovery of applied nitrogen and potash. One of the most important reasons is the fact that practically all soils "fix" a considerable portion of P_2O_5 applied, making it unavailable to crop plants. Frequently, five to ten times more P_2O_5 than the crop is expected to take up must be added to the soil, because of the reduced availability of P_2O_5 caused by this soil fixation. As residual P_2O_5 builds up, part of it becomes available to later crops, so that in subsequent years rates of phosphate application may be decreased.

Phosphorus Benefits Irrigated Crops

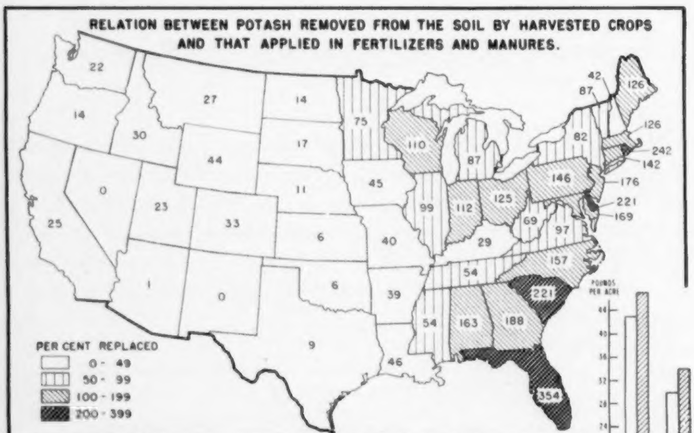
The replacement of P_2O_5 in the Pacific States (now 83 percent) will doubtless increase with the expanding use of fertilizers in that region. An increasing number of instances where phosphate fertilization improved crop yields on irrigated lands is being reported.

The West Central States have the lowest rates of P_2O_5 replacement in the country, with the exception of Nevada. Typical of this extreme is North Dakota, where only 14 percent of the P_2O_5 removed is being replaced. The levels of P_2O_5 in these soils are being lowered. Continued depletion of P_2O_5 reserves will eventually result in shortages of this nutrient, which is so important to satisfactory crop growth and yields.

Potash Removal Highest In East

Potash removal in harvested crops amounts to 43 pounds per acre in the New England region, and exceeds 25 pounds per acre

(Continued on page 71)



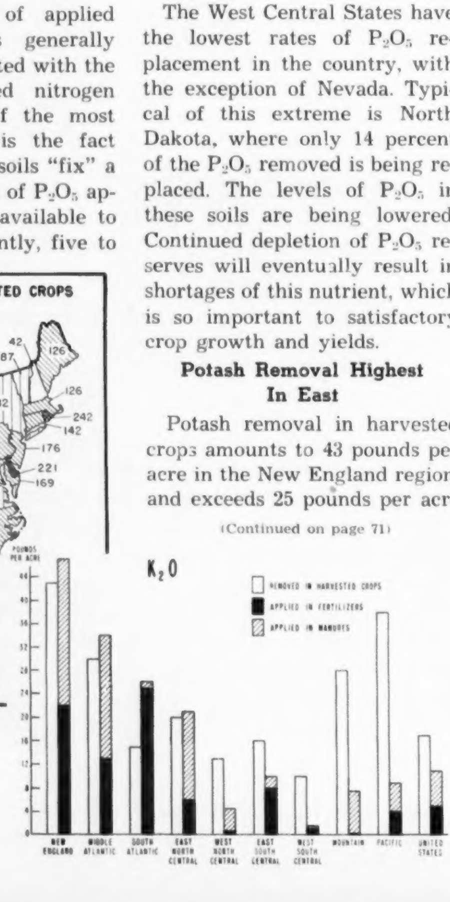


Figure 5 (above) shows the percent of potash replaced in the various states, as related to amount removed by harvested crops.
Figure 6 (right) shows how the removal of potash (per acre) compares with amounts added as manures and fertilizers by areas.

Robert C. Simms

Personals

William R. Thurston, president of **Thurston Chemical Company** of Joplin, Missouri, Tulsa, Oklahoma, and Lawrence, Kansas, has announced the appointment of **Robert C. Simms** as assistant to the president.

For the last twenty four years, Simms has been associated with the **Naco Fertilizer Company** of New York City. He resigned February 15 as president, general manager and director to join the Thurston Company.

Thurston and Simms will be assigned to duties created by company expansion and other duties resulting from regulations concerning allocations, pricing and related problems.

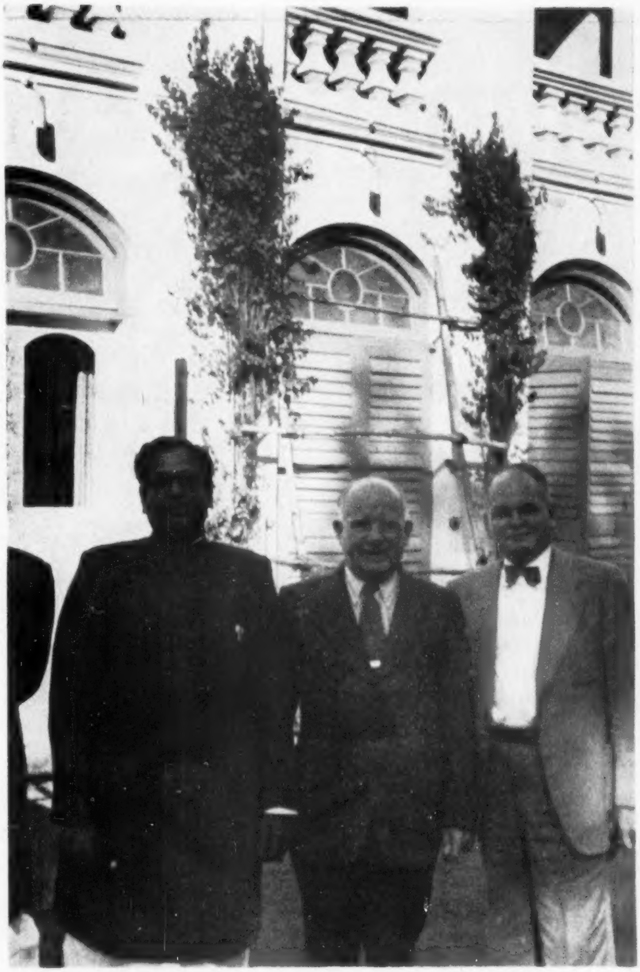
Before entering business, Simms studied agriculture at the University of Illinois and since that time has played an important part in the growth of the fertilizer industry.

* * *

M. H. Mc Cord has been named treasurer of the **Naco Fertilizer Co.,** according to an announcement of **Kenneth D. Morrison,** president. **John H. Kraus** has been named administrative assistant to Mr. Morrison.

Mr. Mc Cord formerly held the post of treasurer of the **Davison Chemical Corp.,** in addition to some government service abroad. He will make his headquarters in Charles-

Bemis Man In India



W. D. McLean of Bemis Bro. Bag Co., Boston, is shown in the picture (right) with K. D. Jalan, Chairman of the Indian Jute Mills Association (left) and J. R. Walker, immediate past Chairman of the Association (center). The picture was taken at the Bengal Club, Calcutta, India. Mr. McLean's journey to India was in the interest of Bemis' burlap requirements.

ton, S. C. when the fertilizer company moves its main offices there in April.

Mr. Kraus comes to Naco, the **W. R. Grace & Co.** subsidiary, from **Mathieson Chemical Corp.** where he was administrative assistant to the manager of the Eastern Division Agricultural Chemicals, in Baltimore.

* * *

Elmer S. Nelson has resigned as executive secretary of **California Fertilizer Association**, effective the end of this month to become a consultant to private business on federal regulations.

* * *

At the annual stockholders' meeting of the **Bemis Bro. Bag Co.**, held in St. Louis, the following persons were re-elected to serve as Directors of the company for 1951:

A. V. Phillips, H. H. Allen, F. M. Ewer, D. Belcher, C. F. Scott, F. G. Bemis, R. D. McAusland, P. E. Morrill, Judson Bemis, A. H. Clarke, H. V. Howes, G. H. Parsons, H. P. Claussen.

At the same time, the Board of Directors of the Bemis Bro. Bag Co. re-elected the following to serve as Officers of the Company for the coming year:

President, F. M. Bemis; Vice-Presidents, D. Belcher, P. E. Morrill, F. M. Ewer, H. H. Allen, H. V. Howes, H. P. Claussen, Judson Bemis, R. D. McAusland, A. H. Clarke, C. W. Loomis; Treasurer, T. W. Little; Secretary and Assistant Treasurer, R. Ramsay; Assistant Secretary, D. M. Finley.

A. C. Ewer, manager of the **Bemis Bro. Bag Co.** plant at Brooklyn, New York announces the appointment of **A. E. Dalldorf** as Sales Manager.

Mr. Dalldorf started with the company in 1936 as a stock clerk. In 1944 he was made a sales correspondent, and in 1946 became a salesman.

After transfer to Philadelphia from 1947 to 1950, Mr. Dalldorf returned to Brooklyn where he was recently promoted to his present position as sales manager.

* * *

Melvin H. Baker, president of **National Gypsum Co.** has been appointed a member of the commission to study the establishment of a Buffalo Port Authority.

* * *

C. B. E. Rosane, J. M. Fasoli and **Ames B. Hettrich**, officials of **American Cyanamid** were entertained in early March by leading citizens of Savannah, as they inspected a proposed site there for a new plant.

* * *

Dr. William S. Knowles of the **Monsanto Chemical Company's** St. Louis Organic Chemicals Division, and John W. Cross of their Everett, Massachussetts, Merrimac Division were given leaves of absence with full salary for a year of academic study at universities of their choice. Since 1946 19 other Monsanto scientists have received similar leaves.

* * *

Hugh W. Sloan, vice president of **St. Regis Sales Corporation** and presently Pacific Coast manager of the company's Multiwall Bag Division, has been transferred by **St. Regis Paper Company**, to the New York office, effective April 2, 1951. Mr. Sloan will assist **Arch Carswell**, vice president of the company and general sales manager for the division, in the direction of bag sales.

Robin G. Swain, production manager of the company's West Coast bag plants, will succeed Mr. Sloan as Pacific Coast Manager.

* * *

Harry G. Andersen, heretofore district sales engineer at Milwaukee, Wis., has been appointed by **Link-Belt Company** district manager at Birmingham, Ala., with headquarters in the Comer Building, 2100 Second Ave N.

Mr. Andersen succeeds **J. T. Bell, Jr.**, who has been called back into the service of the U. S. Army, Corps of Engineers.

OBITUARIES

Bailey E. Brown, former head of research unit of Summers Fertilizer Company, Baltimore, died March 9 in Washington. Mr. Brown had been senior biochemist of USDA, retired after 45 years of service, and assumed the Summers post. He was an authority on plant nutrition with special emphasis on potatoes.

Hammond Milton Crum, 55, district sales manager of the International Minerals and Chemicals Corporation's Potash division, died March 17 in Atlanta after a brief illness.

Shirley B. Hunter, for forty years a representative of Armour Fertilizer Works, retiring three years ago, died February 20 in Birmingham, Alabama.

Rupert A. McGinty, 64, vice director of the South Carolina AES, died at his home in Clemson, March 1, after several months of ill health.

George S. McIntosh, 59, chief of fertilizer distribution for the Tennessee Valley Authority, died of a heart ailment in Knoxville, Tennessee, March 4, after a brief illness.

Mr. McIntosh had been with TVA since 1934. During World War II he was loaned to OPA, WPB, and WFA. Prior to joining the TVA staff, Mr. McIntosh had been manager of the Alabama Chemical Company fertilizer plant at Memphis for six years, and before that had been employed by the American Agricultural Chemical Company in Alabama and Georgia for 10 years.

Isaac Grier Wallace, 65, who operated I. G. Wallace and Son Co., and was well known in the fertilizer industry, died March 3 at his home in Charlotte, North Carolina. He had been in declining health for several years.

MARKETS and PRODUCTION

FERTILIZER TAX TAG SALES AND REPORTED SHIPMENTS
(In Equivalent Short Tons)
Compiled by The National Fertilizer Association

	February		January		July-January	
STATE	1951	1950	1951	1950	1950-51	1949-50
N. Carolina	1/	1/	337,648	288,052	728,933	545,623
S. Carolina	159,195	198,660	188,934	157,950	497,145	358,094
Georgia	182,753	208,697	256,009	149,329	535,462	366,542
Florida	126,005	139,328	153,475	122,023	680,695	590,652
Alabama	162,242	110,261	56,425	41,839	283,439	207,356
Tennessee	56,769	26,895	21,132	16,084	140,650	117,127
Arkansas	41,894	24,649	40,282	16,915	116,215	84,333
Louisiana	40,465	36,958	43,161	19,631	117,388	76,075
Texas	52,410	67,888	61,480	40,354	317,589	255,003
Oklahoma	1/	1/	12,417	8,662	63,025	63,180
TOTAL SOUTH	821,733	813,336	1,170,963	860,839	3,485,541	2,664,985
Indiana	76,665	73,822	127,610	98,375	623,774	503,794
Kentucky	60,635	96,961	94,782	57,415	302,545	223,462
Missouri	56,310	56,362	135,087	77,504	398,267	245,488
TOTAL MIDWEST	193,610	227,145	357,479	233,294	1,324,586	972,744
GRAND TOTAL	1,015,343	1,040,481	1,528,442	1,094,133	4,810,127	3,637,729

1/ Oklahoma and North Carolina report tax tag sales and tonnage shipments 30 days after the end of the current month. Oklahoma and North Carolina tag sales and shipments for January 1951 were 12,417 and 337,648 tons respectively, compared to 8,662 and 288,052 tons during January 1950.

U. S. EXPORTS AND IMPORTS OF FERTILIZER AND FERTILIZER MATERIALS, IN SHORT TONS
Summarized by The National Fertilizer Association from Bureau of the Census Records

	EXPORTS				IMPORTS			
Item	Dec. 1950	Nov. 1950	Oct. 1950	Oct.-Dec. 1949	Dec. 1950	Nov. 1950	Oct. 1950	Oct.-Dec. 1949
NITROGENATES	57,602	46,995	34,279	508,208	223,170	97,106	147,304	243,251
Amm. sulfate	13,306	23,207	27,837	298,345	117,800	17,277	20,849	30,909
Nitrate soda	10,670	2,710	2,949	2,011	50,064	34,134	70,666	104,005
Amm. nitrate	4	2	97	113,442	25,518	17,436	22,306	36,106
Calcium cyan.					7,988	9,265	7,665	16,679
Calcium nit.					4,973	0	10,969	10,012
Amm. phosp.	29,131	15,488	50	82,997	11,233	10,206	9,355	32,974
Organics	803	598	567	1,941	1,489	2,168	2,874	8,286
Other	3,688	4,990	2,779	9,472	4,105	6,620	2,620	4,280
PHOSPHATES	77,061	148,979	139,760	403,085	9,187	5,503	4,542	18,262
Fla. hard rock	5,517	5,206	3,469	57				
Land peb. rock	45,171	101,208	95,687	291,303				
Other rock	10,662	19,986	21,258	56,103				
Normal super	12,523	22,141	18,619	50,727	140	525	1,061	216
Conc. super	3,042	271	660	4,609	0	500	0	0
Other P_2O_5	146	167	67	286	9,047	4,478	3,481	18,046
POTASH	8,889	9,627	11,983	27,156	29,343	43,723	33,814	4,760
Muriate	8,225	7,967	10,017	22,145	25,096	34,880	25,318	1,107
Other	664	1,660	1,966	5,011	4,247	8,843	8,496	3,653
MIXED FERT.	1,699	1,059	3,509	3,051	2,876	3,872	4,131	9,609
GRAND TOTAL	145,251	206,660	189,531	941,500	264,576	150,204	189,791	275,882

Tax Tag Sales Drop In February

February tax tag sales figures from 11 of the 13 reporting States represent a slight decrease of fertilizer sales compared to February, 1950, according to The National Fertilizer Association. Sales in the eight southern States rose 1 percent while tax tag sales in the 3 midwestern States dropped 15 percent during this same period.

January, 1951, tag sales for the 13 reporting States represented 1,528,000 equivalent tons compared to 1,094,000 tons for January, 1950, an increase of 40 percent.

Exports Drop—Imports Increase

Fertilizer exports for the last three months of 1950 were 401,000 short tons less than the same period of 1949. Imports during October-December were 329,000 tons greater than the corresponding period of 1949. Net imports over exports for the final quarter of 1950 amounted to 64,000 tons.

Exports for the 12 months of 1950 were 3,710,000 tons while 1,900,000 tons were imported during the past year.

Of the major export categories during 1950, ammonium sulfate was the largest with 811,580 tons. Among the materials imported during the past year, nitrate of soda led all the rest with 615,673 tons.

1950 Super Sets Production Record

Total production of superphosphate, 18 percent A.P.A. basis, during 1950 was 3.6 percent greater than in 1949. The manufacturer of 10,887,000 tons last year exceeded 1949 output by 379,000 tons. The prospects for meeting the 1950 record output in 1951 are very poor because of the serious shortage of sulfuric acid currently being made available to fertilizer manufacturers.

Treble superphosphate proruction was boosted from 549,000 tons during 1949 to 687,000 tons in 1950, an increase of 25 percent. The December 1950 carryover of concentrated super —only 55,000 tons—was half that at the end of December 1949.

U. S. SUPERPHOSPHATE SUMMARIES, in Thousands of Short Tons
Based on Data for 199 Plants, Representing Total U. S. Production
Compiled from Reports Submitted to The National Fertilizer Association
and a Summary of Reports Submitted to the Bureau of the Census

	December 1950			Total, 18% APA Basis				Conc. (45% APA)	
	Normal 18% APA Basis	Wet Base 18% APA Basis	Conc. 45% APA Basis	December 1950	December 1949	Jan.-Dec. 1950	Jan.-Dec. 1949	Jan.-Dec. 1950	Jan.-Dec. 1949
Stocks, first of period	960	13.8	65	1,137	1,311	1,421	1,408	104	71
Production	825	6.5	53	963	836	10,887	10,508	687	549
Received from other plants	13	0.0	0	13	11	105	95	0	0
Book adjustments	9	0.0	0	9	1	72	45	—4	6
Total supply	1,807	20.3	118	2,122	2,159	12,485	12,056	787	626
Shipments	432	1.8	62	590	422	6,822	6,117	719	497
Used in reporting plants	340	.1	0	341	317	4,475	4,517	13	24
Total disposit'n	772	1.9	62	931	739	11,297	10,634	732	521
Stocks, end of period	1,035	18.4	56	1,191	1,420	1,188	1,422	55	105

ORGANICS: Organics for Fertilizer use this Season continue in tight supply with demand fairly active. Some recent lots of Domestic Nitrogenous Tankage were sold for use this Season at around $6.00 per unit of Ammonia, in bulk, f.o.b. shipping point. Limited supplies of Imported Nitrogenous Tankage have been offered at around $6.25 per unit of Ammonia, in bags, c.i.f. Atlantic Ports, for Summer and Fall shipment. Imported Castor Pomace has been offered in limited quantity at prices ranging from $45.00 to $48.00 c.i.f.

CASTOR POMACE: The market is relatively bare of offerings although a small quantity was recently quoted at $5.50 per unit of Ammonia, in bags, f.o.b. North Eastern production point, for shipment as far forward as June. This is material guaranteed 5.75% Ammonia.

DRIED GROUND BLOOD: The Chicago market is quiet and unchanged at $9.25/$9.50 per unit of Ammonia delivered the Chicago area. The New York market last traded at $9.00 with previous sales at $9.50.

POTASH: Supply continues tight and unable to keep up with the demand. Boxcar shortages seriously interrupted movement from the mines last week.

GROUND COTTON BUR ASH: This source of Potash primarily in the form of Carbonate of Potash, is available in fair supply for immediate and spread March/April/May/June shipment. This material tests 30%/40% K_2O Potash. Some suppliers' material is testing rather consistently around 40% K_2O.

PHOSPHATE ROCK: Supply position is comfortable and movement somewhat curtailed by the shortage of Sulphuric Acid.

SUPERPHOSPHATE: Supplies of normal Superphosphate for this Season are in short supply generally and in some areas critically short. Triple Superphosphate demand continues excessive in relation to supply.

SULPHATE OF AMMONIA: This market is very tight indeed with the coke oven producers unable to offer spot supplies. Movement is primarily against existing Contracts.

AMMONIUM NITRATE: Demand continues very strong and supply lagging behind the call. Prices continue firm at ceiling levels.

NITRATE OF SODA: Demand for Imported Nitrate of Soda is very strong and in certain areas supply is inadequate to meet the call. Prices remain firm at ceiling levels.

GENERAL: Heavy demand for Fertilizers in practically all sections of the country has placed the three major Fertilizer ingredients, Nitrogen, Superphosphate and Potash in tight supply position. Of the three, Superphosphate appears to be the greatest in demand. Prospects are that prices of this article will be at maximum ceiling levels for the balance of 1951 and probably into 1952.

REPLACING

(Continued from page 64)

in the Middle Atlantic, Mountain and Pacific regions (Figure 6, white bars). Lowest removals of 10 and 13 pounds of potash per acre are found in the West North Central and West South Central regions, where grain cropping is the chief agricultural pursuit.

An average of 25 pounds of potash per acre are added by fertilizers in the South Atlantic region, with the smallest additions in fertilizer in the four Western regions (Figure 6, black bars).

Potash additions in manure (Figure 6, hatched bars) are greatest in the New England, Middle Atlantic, and East North Central regions, exceeding the potash additions in fertilizers. A comparison of Figures 1 and 5 shows that manure contributes similar portions of the total potash and total nitrogen added to our soils.

Two-thirds of Potash Is Replaced

About two-thirds of the potash removed in harvested crops is being replaced for the country as a whole, with fertilizers and manure each making up approximately half of the addition.

Nearly twice as much potash is being returned to the soils of the South Atlantic region as is being removed in the form of harvested crops (Figure 5). The soils of this region, and of the East South Central region, are highly weathered, and potash is readily lost by leaching. The need for replacing the potash removed in crops is probably greater in this area than in any other region of the country.

The replacement of available potash in the soils of the New England, Middle Atlantic, and East North Central regions is approximately 100 percent. Most of the soils of this area give a natural release of 25 to 50 pounds or more of potash per acre each year from soil minerals. This replacement from natural reserves is an important factor in maintaining the supply of available potash in the soils of these regions.

Western Soils High in Potash

Farmers of the West North Central, West South Central, Mountain and Pacific regions are expected to continue for a number of years to replace only about one-third of the potash

removed in crops. The soils of these regions are only slightly weathered, are high in potash-bearing minerals, and readily release potash from mineral to available form.

By way of summary, here is the situation for the United States as a Whole:

(1) Additions from manure and fertilizers combined replace only slightly more than half of the nitrogen removed in harvested crops. Approximately two-thirds of the added nitrogen is in the form of manure, the other third as commercial fertilizer.

(2) Phosphate (P_2O_5) additions are greater than removal in harvested crops by 40 percent. Fertilizers supply slightly over two-thirds of the P_2O_5 added.

(3) About two-thirds of the potash removed in harvested crops is being replaced, with fertilizers and manure each supplying approximately half of the addition.

Chemical Engineering Opens Mississippi Office

Chemical Engineering Service, Green Bay, Wisconsin, announces the opening of offices in Gulfport, Mississippi, in order to better serve its many friends throughout the Southern half of the country. In opening its offices at Gulfport, this company expresses deep gratitude for the confidence the industry has shown in them. "We expect to continue our efforts to improve our plants and equipment" the announcement states. "At the present time, we are working on new machines which we hope to offer to the industry in the near future; included in this equipment is an automatic mixer with automatic ammoniation, a full dial magnetic scale bagger, and a 10 ton per hour acidulating unit.

"At the present time we are sending out a weekly bulletin to the industry, listing new and used equipment and a free materials exchange for all manufacturers."

Swift Plants Honored

Thirty plants of Swift & Co in the U. S. and Canada have been featured in the March issue of National Safety Council News for their remarkable safety records. Injury-free days total more than 35 years.

Copper: IN HAVANA SEED TOBACCO PRODUCTION IN CONNECTICUT

By Edward F. Perreault

Table 1. Yield And Grading Records Of Copper Sulphate Test 1947

Pounds Copper Sulphate per acre	Yield pounds per acre	Grade Index	Crop Index	Relative Crop Value
None	2100	.468	982.8	100.0
18	2449	.514	1258.8	128.0
36	2362	.546	1289.7	131.2
72	2423	.546	1323.0	134.6

Copper although considered an important element in plant growth the requirements of which is lower, for instance, than that of boron, plays an important part in tobacco growth, yet only a trace seems to satisfy the need for the catlytic function it performs in the plant.

The recent disclosures by T. R. Swanback, agronomist, of the Windsor Tobacco Laboratory of the Connecticut Agricultural Experiment Station brought out some very interesting highlights on the use of this element in tobacco experimental research work. Although the soils in Connecticut tobacco fields contain sufficient copper for normal plant growth, it was nevertheless deemed worthwhile to carry on experiments to determine if applications of copper sulfate would benefit Connecticut tobacco as it has crops in other sections of the country. It was also felt that the relatively high fertilizer requirements for cigar tobacco, might also reveal that the tobacco growers were not receiving the full benefit from the annual application of fertilizer.

Mr. Swanback undertook to establish what the answer to this question was in a series of experiments which began in 1947 which ultimately followed with his report which followed after three years of intensive research on the use of copper sulfate in tobacco production.

As a preliminary trial in 1947, three plots (19x40 ft.) were fertilized at the regular rate of 3,400 pounds 6-3-6 to the acre. Copper sulfate, mixed with the fertilizer, was added at the rate of 18, 36, and 72 pounds per acre. The adjacent part of the field, receiving the equivalent amount of fertlizer but no copper, served as a check plot. The entire field was planted with Havana seed Tobacco.

In 1948 a more extensive experiment was laid out. Results from the previous year had indicated the necessity of a closer observation on amount of copper sulfate application between the 18 and 36 pounds rates. Thus, it seemed logical to include a rate of 27 pounds. The 72-pound rate was omitted. Therefore, four rates of 18, 27, 36, and 54 pounds of copper sulfate per acre were employed. Each rate was applied in quadruplicate plots, with no copper sulfate added to four check plots. All the plots were arranged at random within the four blocks. The same acre-rate and type of fertilizer were used as in 1947, and Havana seed tobacco was planted.

Based on 1948 results, only one rate, 20 pounds of copper sulfate to the acre, was tried in 1949. Quadruplicate plots with this treatment were compared with the same number of check plots, all randomized in one block. The plot size was increased to 1/40 acre. Otherwise, the fertilization and plants remained the same as in previous experiments.

Soil samples were taken and analysis made during the 1948 season for the purpose of estimating the effect of copper on nitrification and the amount of active copper in the soil.

Results of the 1947 field experiments indicated that the copper sulfate plots grew considerably larger than tobacco in the surrounding areas. In fact, the tobacco on the three plots in question appeared to be the largest on the experimental farm.

Little difference was noted among the plots which received various amounts of copper sulfate. During the early part of the season, however, it was noticed that the plants on the plot

which received the highest rate of copper sulfate were darker green and progressed slower than the rest of the tobacco. It is possible that the higher rate had a depressive effect, although the final results (Table 1) indicated that possible injury from surplus $CuSo_4$ was of a passing nature.

Grade index is a figure which represents the relative value of a lot of tobacco computed on the percentage weight of each grade of leaves in the lot and the relative value of these grades.

Crop index is the product of grade index and yield.

From the results obtained in the initial experiment it is clearly demonstrated that both the yield and grading (quality) of tobacco improved 28, 31.2 and 34.6 per cent, respectively, from the application of 18, 36, and 72 pounds of copper sulfate per acre to tobacco land. This improvement was balanced about equally between yield and grading.

The maximum increase in yield was obtained with the lowest application of copper salt, while the higher index values were secured with the higher copper rates. The optimum, therefore, seemed to fall between 18 and 36 pounds per acre.

Burn tests which is an important test made to determine the capacity of tobacco to hold fire were made on cured (not fermented) leaf samples showing the following results:

Pounds of Copper Per Acre	Av. duration of burns in seconds
18	41.3
36	45.3
72	48.3

The experiment further proved that the application of copper sulfate to tobacco fields has no adverse effect on burn. Since no reduction in duration occurred, rather, duration of burn increased as copper sulfate application was increased, this proved promising enough to warrant more extensive testing the following year.

In the 1948 experimental plantings the tobacco grew vigorously on the test plots and was noticeably better than that on surrounding fields. In places, however, independent of treatments, area of inferior growth were found. Further examination of the roots of plants showed the presence of many nematodes which may have account-

TABLE 2

Treatment	Plot	Yield lbs. per A. Plot Av.	Average	Grade Index Plot Av.	Average	Crop Index	Relative crop values	Original (not corrected) relative crop values
Check	A	1889[1]		.438[1]		906.5	100.0	100.0
(No. Cu)	B	1875		.487				
	C	1980	1988	.440	.456			
	D	2209		.457				
18 lbs.	A	1983[1]		.490[1]		1030.0	113.6[2]	116.3
$CuSO_4$	B	1969		.495				
Per A	C	2204	2102	.500	.490			
	D	2250		.508				
27 lbs.	A	1969		.498		962.8	106.2	106.6
$CuSO_4$	B	2160		.448				
Per A.	C	1940[1]	2027	.435[1]	.475			
	D	2037		.479				
36 lbs.	A	2016		.476		993.2	109.6	116.3
$CuSO_4$	B	2070		.490				
Per A.	C	2250[1]	2091	.495	.475			
	D	2029		.440				
54 lbs.	A	1861		.438		895.4	98.8	105.5
$CuSO_4$	B	2063		.465				
Per A.	C	1956[1]	1968	.446[1]	.455			
	D	1990		.469				

1. Corrected values
2. Statiscally significant difference from check, at odds 19 to 1.

ed for the poor spots in the field.

An adjacent field showed a near crop failure, definitely caused by nematodes. In compiling the yield and grading data, therefore, it was necessary to correct statistically four of the individual plot results (Table 2).

Because of the extremely dry growing season during the early part of 1949, it was necessary to irrigate the field five times at about a week to 10-day intervals. With ample soil moisture there was vigorous growth and slightly better appearance of the tobacco receiving "copper."

This improvement was noted particularly in grading, as revealed when the crop was sorted and weighed. Data collected at that time are shown in Table 3. It was found that both yield and grading of tobacco grown with copper sulfate were far superior to the check plots. The improvement in crop value (yield and grading), amounting to 26 per cent, is highly significant. Of this amount, grading accounted for about 15 units and yield, for the balance.

Normally the riper leaves (but not the ripest) which are situated two-third up the stalk of the tobacco plant, are considered the most valuable. The application of copper sulfate indicated a reduction in the amount of less desirable leaves ("darks") at the upper part of the plant by about 6 per cent (by weight). This also suggest that copper sulfate has a tendency to speed up the ripening process to some extent.

Burn tests conducted on leaves from the 1949 crop showed the

Table 3. Yield And Grading Records of Copper Experiments, 1949.

Treatment	Plot No.	Yield lbs. per acre Plot	Yield lbs. per acre Av.	L	M	LS	SS	LD	DS	F	B	Grade index Plot	Grade index Av	Relative crop value
Regular fertilizer without $CuSO_4$	1	1902	1855	2	3	42	5	28	8	8	4	.417	.403	100.0
	2	1892		6	5	29	9	31	10	6	4	.414		
	3	1835		4	6	32	8	31	10	8	1	.414		
	4	1791		3	4	23	13	33	14	8	2	.368		
Regular fertilizer with 20 lbs. $CuSO_4$ per A.	1	2015	2028	8	8	36	6	29	6	5	3	.459	.463	126.0
	2	2121		9	7	35	6	29	6	6	2	.467		
	3	1995		10	8	31	8	28	7	6	2	.464		
	4	1980		9	8	32	8	28	9	5	1	.462		

(Percentage of grades: L, M, LS, SS, LD, DS, F, B)

Check	"seconds"	14 seconds	Av. 10.5 seconds
	"darks"	7 seconds	
Cu	"seconds"	23 seconds	Av. 15.5 seconds
Treatment	"darks"	8 seconds	

following results, in duration of burn:

Final average figures for the check and the treatment was determined on 160 individual tests. The burn test definitely indicated that copper sulfate increases the burn and will not impair the burn of tobacco.

Although previous experiments carried on in Colorado in 1916 where the rate of copper sulfate was used at the rate of 100 pounds per acre demonstrated that the amount of nitrates was reduced by about 60 per cent on fallow soil, as compared with the check plot.

In the experiments carried on by Mr. Swanback this tendency seems to show the reverse with small amounts of copper sulfate, as suggested from the results of nitrate determinations in 1948 (Table 4). The lowest rate of copper sulfate application (18 pounds per acre) consistently caused a higher rate of nitrate production than the check plots. Some stimulation also occurred at the rate of 27 pounds per acre. In the final analysis, it is safe to conclude that a rate of 20 pounds of copper sulfate per acre will have no harmful effect on nitrification, but might instead be beneficial in that respect.

Determination of Copper in Soil

Analysis for determination of copper available in test plots were made in 1949. Although up to the present date no satisfactory method has been devised to determine this factor to give accurate results, the use of spectographic analysis was considered the best method so far devised.

Spectographic analyses were made by the Department of Analytical Chemistry at the Connecticut Agricultural Experiment Station in New Haven, Connecticut, to determine total copper on soil samples from all plots in the 1948 tests. The results of these tests, each an average of four plots, are listed below:

Pounds $CuSO_4$ per acre	Total copper (p.p.m.)	Expected content Cu^2(p.p.m.)
None	5	5
18	6.5	7
27	7.5	8
36	6.5	9
54	10.0	11

Mr. Swanback discovered with one exception, the recovered copper was only one-half to one part per million less than the expected amount. This further suggest that practically all the copper added remains in the soil. Carrying on further experiments on these samples showed that the copper remains in a fixed form in the soil. Active

Table 4. Nitrate Nitrogen In Soils Of Copper Sulfate Plots, 1948.

Copper sulfate per acre	NO_3-N[1] in parts per million June 15	July 15	August 15	Relative NO_3-N producing Capacity
None	8.7[2]	61.8	3.7	100
18	10.1	83.5	6.6	135
27	9.1	75.9	6.1	123
36	8.5	59.3	3.4	96
54	8.2	59.7	3.7	96

1—The field before application of fertilizer contained only .44 p.p.m. NO_3N.
2—Each figure represents the average of four replicates.

or readily available copper was determined by the Hurwitz process with the substitution of soybean meal instead of oat-straw or alfalfa meal as recommended, since it was found that this gave better results. With the modified method, the soils were extracted and Cu content was determined colormetrically. The average results of these tests are given below:

Check	0.375 p.p.m active Cu
36 lbs $CuSO_4$ per A.	0.715 " " "
54 " " " "	0.900 " " "

Utilizing the more reliable method of determining Cu content from soil extracts all the treatments in quadruplicate were subjected to spectographic analysis. The results listed below represents an average of four replicates.

Check	0.475 p.p.m active Cu
18 lbs. $CuSO_4$ per A.	0.200 " " "
27 " " " "	0.710 " " "
36 " " " "	1.340 " " "
54 " " " "	1.190 " " "

Further tests were conducted to determine to what extent how much copper, if any is absorbed by the tobacco leaves. Analysis in this case were made in all three years the experiments were conducted. After grading, representative samples of the various grades, the tobacco was oven-dried and portions were ground to a fine powder in a porcelain mortar. Weighed portions were ashed and dissolved in solutions of strong acids and subjected to spectographic analysis for Cu. The results of these tests are listed below:

Average Cu content (p.p.m.) of quadruplicate tests, air-dried basis:

Pounds $CuSO_4$ per acre	1947	1948
None	58	47.5
18	56	44.5
27	....	55.1
36	37	37.0
54	....	37.0
72	23	....

The 1949 experiments, based on only one application of 20 pounds of copper sulfate per acre, revealed that an average of 72 p.p.m. of copper was found in leaves from the copper treated plants, compared with 88 p.p.m. from the untreated plots.

The experiments also revealed that with one exception, there is less copper deposited in leaves when copper sulfate is supplied in the soil than without it. This trend for less absorption of copper in the leaf seems to be more apparent when more copper sulfate is supplied to the crop. While the average of the check for the first two years amounts to 53 p.p.m. Cu, the average of all the copper treatments was only 41 p.p.m.

Additional tests made besides copper, of some of the other mineral constituents in the leaf revealed that the chemical constituents in the leaf is not altered by the addition of copper sulfate to the fertilizer on which the crop is grown. Therefore it is obvious that copper is not likely to hamper the growth of tobacco by holding up essential plant nutrients in the soil.

The final analysis of Mr. Swanback's experiments brings out conclusive proof that the dividing line between materials used as soil amendments and those used as plant nutrients

From Three Crops Of The $CuSO_4$ Experiments, in 1947, 1948 and 1949.

Treatment	Percentage on air-dried basis[1]									p.p.m.
	K	Ca	Mg	P	Mn	Fe	Al	Zn	Na	B
Check	3.64	4.24	1.00	.30	.051	.078	.073	.029	.07	53
Copper	3.45	4.35	1.03	.30	.055	.078	.068	.030	.09	50

1—Each figure represents 12 observations on 24 determinations by spectographic analysis method.

cannot be sharply drawn, since most of the materials used for land improvement contain some plant food. The introduction of copper sulfate material can be aptly classified as an amendment and a nutrient, at least in the case of organogenic soils, which the experiments clearly indicated in the final analysis.

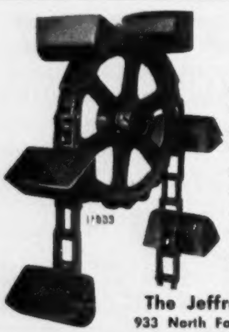
Most of the Connecticut tobacco fields contain mineral soils and hence cannot fix large quantities of copper sulfate. Copper sulfate added to this type of soil indicates is not utilized as a nutrient but is utilized as a soil amendment. Within the 18 to 27 pounds per acre range, the results suggested that nitrification is stimulated by copper sulfate application. Because it is not understood what course this material takes in its change of soil conditions, the problem is to be given further study.

In view of the remarkable improvement obtained in crop values through the application of copper sulfate to the soil, with no harmful results occurring on the crop or to the land, it is concluded that small quantities of this material should be added to the tobacco fertilizer. Mr. Swanback suggests that copper sulfate be used at the rate of 20 pounds to the acre. He also suggests that occasional checking of the status of active copper in the soil be determined. This is particularly important if tobacco is to be grown on old potato land where copper fungicides have been used. Mr. Swanback further advises that a couple of sprayings with Bordeaux mixture should deliver more copper per acre than the recommended 20-pound rate of copper sulfate.

In summing up the final results obtained through the three-year experiment with copper sulfate in Connecticut tobacco land in which Havana seed tobacco was planted, an increase of 13 to more than 26 per cent in crop value was realized.

Nitrification appeared to be stimulated within the range of 18 to 27 pounds of copper sulfate per acre. The fire-holding capacity (burn) of tobacco was not in the least retarded through the use of copper sulfate; neither were the potash and the chief mineral constituents of the tobacco leaf altered as compared with tobacco from check plots.

The addition of copper sulfate to tobacco land at the rate of 20 pounds to the acre seems counterindicated, but growers are cautioned to check occasionally the status of active copper in the soil.



Copper: WHAT HAPPENED AT COPPERHILL

By Wylly Folk St. John

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As you approach Georgia through the green hills and valleys of lower Tennessee, there comes a point where the landscape abruptly, startlingly changes.

Instead of the verdant slopes where the laurel is waiting to flower in pale pink and the rhododendron in purple and rose—suddenly you are driving through an area barren of any leaf or blossom. Vast mounds and rolling ridges of bare red clay appear as though they had been poured while thick and about to harden. There are occasional blackened stretches and deep grayed gullies. You look about apprehensively for the volcano which must have spread this peculiar lava-like surface over the once-pleasant earth. Here and there a small house huddles on the denuded hillside, with no tree to shade it, no stalk of grass, even, for an ant to hide behind. Streams, or perhaps rainwater, have cut strange unorthodox patterns in the convex clay hillsides. Over about 36 square miles the devastation is continued.

This unique-looking section of countryside, about 20 miles above Blue Ridge, Ga., is known as the Ducktown Basin, or the Copper Basin. There's no other place anything like it, they say, short of the Mojave Desert. Tourists invariably stop at the next town—Copperhill, Tenn.—to inquire what curious catastrophe killed all the vegetation. It looks like the primordial world in Chaos before the third day of Creation.

The answer is "copper." If there had never been any copper mined here, the pines and wild honeysuckle and partridge berries and laurel would grow just as thick here as over the rest of Georgia and Tennessee. This picturesque wasteland resulted from the early methods of "heap roasting" copper ore, out in the open. The surrounding timber was cut for fuel, the sulphur dioxide fumes that were released in the roasting process killed all the vegetation, the sedge was burned, and the resulting erosion helped add to the desolation.

The effect of it is the more astonishing when you realize that this method of roasting the ore soon became obsolete, and no more fumes were released after 1907. In this year a plant was built to recover the valuable gas, which is converted into sulphuric acid—a by-product the value of which has come to exceed that of the copper itself. No sulphur dioxide has been escaping for 43 years, but in that near-half-century the vegetation has not grown back.

Just before the war, a re-

forestation project was started by the Tennessee Copper Co. (which owns the mining rights to the entire copper basin, about 100 square miles) in co-operation with the TVA, but the war interrupted it. The seedling pines which were planted on several of the naked slopes are now a respectable size. But the small number of them merely emphasizes the lack of anything green on the rest of the sienna-colored hills. Recently the planting of pines has been resumed, but making a new forest, starting from the bare ground up, is a slow process.

This year, the Tennessee Copper Co. is celebrating the one-hundredth anniversary of the opening of the first mine here—the old Hiwassee mine, in 1850. This area has one of the oldest copper deposits in the country. The ruddy metal was discovered here in 1843, by one Jesse Lemmons. Jesse thought he had discovered gold, according to R. E. Barclay, chief clerk of the company, who has written a book about Ducktown. But what Jesse found on a branch which flows into Potato Creek was a reddish-brown-and-black rock in which he could see large metallic crystals of a deep rich red-gold. Greatly excited, he tied the cuffs of his coat with hickory withes, and filled them with the rocks. Taking the ore back to town, he celebrated his gold strike vigorously, all night. In the morning his "gold" had oxidized and turned brown. It proved to be the red oxide of copper. A boom ensued, something like the Gold Rush. Land worth 1 cent an acre sold for $1,000 an acre.

A score or more of companies have mined copper here since that time. This region was the chief source of copper for the Confederacy's shell casings and cartridges. The Tennessee Copper Co. is now the sole survivor. Here are the only copper mines in the Southeast, and the only commercial copper plant.

It is a comparatively small producer of copper as such, according to T. A. Mitchell, general manager, who has been with the company for 36 years. There is less than 1 per cent of copper in the ore, and the annual production is only 15,000,000 pounds of copper. The remarkable thing is that the plant's chief products now come from what used to be waste materials—by-products of smelting the copper.

The plant makes over 800,000 tons of sulphuric acid a year, from those sulphur dioxide fumes which killed the greenery in the old days before it was learned how to convert the gas into acid. This is 10 per cent of the sulphuric acid produced in the entire country. Shipped out in tank cars, it is a valuable ingredient for many uses—in making rayon and cellophane, in all the textile industries, in oil refining, in making fertilizers, in the pickling of steel. During the war a high-strength sulphuric acid called oleum, a strategic material, was made here, for use in the manufacture of TNT.

Copper sulphate is another of this plant's chief products: 30,000,000 pounds were produced last year. It is used in fungicides, and mixed with many fertilizers. Thus the food you eat, as well as the textiles for your clothes, may be affected by the copper which made the giant bare spot around Copperhill.

Other by-products of the plant, too, are put to economic use. The slag from the furnace—a spectacular sight when poured out flaming over the hillside about twilight—is recovered and used for ballast on railroads, and for aggregate in concrete. The ore gives up, as well as copper, 450,000 tons a year of iron sinter—a high-grade iron which is sold to iron and steel companies in Birmingham, Ala. This also was in great demand in the war. Zinc is another worth-while by-product, and small amounts of gold and silver, too, are realized from the operations. "In fact," says Mr. Mitchell, "like the pork packers, we've been accused of using everything but the squeal." In the case of copper, the "squeal" is a

small amount of waste in the form of silicate, left after every other part of the ore has been utilized. Even this fine sand could be used to make glass, if any glass manufacturer were interested.

The company has its various plants scattered all over the Ducktown Basin area—at Copperhill, Ducktown, Isabella, and London. It employs about 2,000 people, half of them from the Georgia towns just over the border. Production for the next 30 years is blocked out ahead, and the officials don't anticipate running out of copper. "We feel the copper here will outlast any of us," they say. The ore is being blasted out at the rate of 15,000 to 25,000 tons a shot.

Some of the mines have interesting names—the Eureka vein, for instance, brings up a ridiculous vision of a bearded prospector who remembered Archimedes, shouting the Greek "Eureka! I have found it!" when he came across a rich piece of coppery rock. The Burra-burra mine is named for the Indian word for "big"—and this lode of copper was evidently double-big. Ducktown itself is named for a Cherokee Indian chief who must undoubtedly have waddled—Chief Duck.

The mines, some of which go underground as deep as 2,400 feet, are modernized and improved to such an extent that the National Safety Council has called them the safest underground copper mines in the world. This is one of the few plants to win the Distinguished Service to Safety award of the Council, points out Sam Sharp, safety director.

But the miners are still superstitious. They won't allow a woman to go underground. The old belief, way back yonder, according to Gus Nelson, mine foreman at the Boyd mine, was that every time a woman went down in a mine, a man got killed. There was one occasion here when a woman did go into the mine, dressed as a man—and nothing happened. But that didn't unhex the feminine sex, as far as the miners are concerned. Mr. Nelson says his wife wants to go underground, in spite of the fact that the elevator which descends into the mine is pointedly called the "man cage." He may give in and take her some day—when he's ready to retire.

CLASSIFIED ADVERTISING

For Sale, Exchange and Wanted Advertisements, same type now used, EIGHT CENTS a word for one insertion; TWELVE CENTS a word for two insertions; FIFTEEN CENTS a word for three insertions, and FOUR CENTS a word for each insertion more than three; ADVERTISEMENTS FOR THIS COLUMN MUST BE PAID IN ADVANCE.

SEWING MACHINE SERVICE. Feed dogs remilled, sharpened and hardened like new at ⅓ cost of new feeds. Union Special machines rebuilt one week. New and rebuilt Union Special sewing heads and conveyors bought and sold. E. C. Covell, 719 Murdock Road, Baltimore, Md. 12. Towson 5040 Belmont 4335.

WANTED: A Fertilizer Plant to design by competent, experienced engineer. P. O. Box 495, Lakeland, Fla.

"Wanted: Assistant Superintendent for fertilizer plant by old established Ohio manufacturer. Age, preferably, between 30 and 40 years, with knowledge of production and maintenance work. When replying give experience, reference and approximate salary expected. Address Box 8, c/o Commercial Fertilizer, 75 Third St. N. W., Atlanta, Georgia."

WANTED two hundred tons of Champion Nitrate of Soda, 120 tons Ammonium Nitrate. Farm Services, Covington, Tenn.

WANTED: Three ton per hour used rock mill. Must be in good condition. Box 9, c/o Commercial Fertilizer, 75 Third St., N. W. Atlanta, Ga.

WANTED: Kent Ring Roll Mill to grind Florida Pebble Rock Phosphate, capacity 5 to 6 tons per hour, fineness 80 mesh or better, complete with air separator. Send full particulars to Green Valley Fertilizer & Chemical Co. Ltd., Box 140, New Westminster, B. C. Canada.

AVAILABLE: Feed lot sheep manure, stockyard manure, spent Nuchar black, bat guano, slaughterhouse wastes. Box 4082 Corpus Christi, Texas.

POSITION WANTED: Assistant Sales Manager or Sales Manager. 10 Years successful sales experience (south and east) in fertilizer and superphosphate. Age 33, two years college, married, veteran. Now employed as Assistant Sales Manager branch office national company, but desirous of change. Excellent references. Write Box # 10, c/o Commercial Fertilizer, 75 Third St., NW Atlanta, Ga.

THE DOWD PRESS, INC.